SCIENCE

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CONTENTS

The Social Obligations of the Botanist: DR. W. W. STOCKBERGER 733

Premedical Education: DR. PAUL G. WOOLLEY. 743

Professor Theobald Smith and a New Outlook in Animal Pathology: T. M. P. 751

Scientific Notes and News 754

University and Educational News 758

Discussion and Correspondence:—
Two Undescribed Specimens of Castoroides: NORMAN A. WOOD 759

Scientific Books:—
Kellicott on Chordate Development: J. P. MCM. *Lewkowitsch on Oils, Fats and Waxes:* PROFESSOR A. H. GILL 759

Scientific Journals and Articles 760

Special Articles:—
The Systematic Position of the Mylodont Sloths from Rancho la Brea: DR. CHESTER STOCK 761

The Society of American Bacteriologists: DR. A. PARKER HITCHENS 763

Societies and Academies:—
The American Mathematical Society: PROFESSOR F. N. COLE. *Philosophical Society of the University of Virginia:* PROFESSOR L. G. HOXTON. *The American Philosophical Society* 769

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THE SOCIAL OBLIGATIONS OF THE BOTANIST[1]

THE subject of the address which I am to have the honor of presenting before you this evening was suggested to me on hearing recently a statement to the effect that it is the duty of society to pay for the services of the botanist. It seems to me that there is something to be said on the other side of this question, and, although my predecessors on similar occasions have almost invariably favored you with learned scientific discussions, I shall depart from that ancient and time-honored custom and invite your attention to a consideration of some of the social obligations of the botanist.

A distinguished and honored member of this society has defined botany as that science "that occupies itself with the contemplation of plant as related to plant, and with the whole vegetable kingdom as viewed philosophically—not economically or commercially in its relation to the mineral, on the one hand, and to the animal on the other." From this definition it naturally follows that a true botanist is one who is engaged in research upon plants as such without regard to the relationship they may bear to the welfare and activities of mankind. The history of botany clearly shows that botanists have ever been largely devoted to their science for its own sake, for the pleasure which they might derive from a knowledge of plants. The speculations in which they were absorbed concerned questions of truth and not those of economic values. But throughout the history of the race, the economic aspect of

[1] Address of the retiring president before the Botanical Society of Washington, March 3, 1914.

plants has been of fundamental importance to man, since upon them he has ever looked not only as the chief source of the three great necessities, food, clothing and shelter, but also as the means whereby he might cure his bodily ills or otherwise contribute to his comfort and satisfaction. As society became more and more highly organized, there emerged groups of men whose interest centered upon some particular phase of plant utilization which through long-continued study and observation became sufficiently developed to be recognized as an art. The lineal descendants of these groups we recognize to-day in our practical gardeners, horticulturists, foresters, agriculturists and pharmacists. The radical difference in the point of view, between those devoted to botany as a science and those engaged in the practise of its art, ultimately led to the development of a species of class consciousness more than traces of which unfortunately are still in existence. The botanist dazzled by continued contemplation of the aphorism "science for science's sake" became unable to see any science in the practise of the art of botany, and relegated its followers to the limbo of tradesmen along with the smiths, the carpenters and the shoemakers. On the other hand, the groups interested in the practical or industrial aspects of plants came to look upon the professional botanist as a harmless individual who succeeded very well in entertaining himself, but whose activities were of little if any significance to those whose primary interest in plants was utilitarian.

This class conscious attitude on the part of those who approached the study of plant problems from such widely different points of view led to results of the most profound significance. Botanists in their zeal to preserve their ideal unsullied, and in their fear lest utility should obscure its luster devoted themselves almost exclusively to a dendritic development of their science, the industrial branches of which remained rudimentary if they were not wanting entirely. Until within recent years, the concept of the function and content of the instruction in botany given in our colleges and universities was derived purely from a consideration of the philosophical aspect of botany. In some institutions at least the sentiment prevailed that the courses in botany planned primarily to develop the scientific attitude of mind and habits of thought, had as their chief and legitimate goal the training of students to become teachers of botany. But notwithstanding the increase in the number of institutions of learning, and the consequent multiplication of opportunities for the teacher of this subject to secure a position in which he could maintain himself in a modest way, the possibility of earning a livelihood as a teacher became more and more remote, as an increasingly large number of students graduated and became available as teachers of botany. The inevitable consequence was that many men were turned aside from the pursuit of botany as a profession and entered upon other vocations, which promised to be more remunerative.

But at length there dawned a new conception of botany, one destined not only to modify profoundly the opinion of the public at large with respect to this science, and to revolutionize in many respects the attitude of its exponents in the lecture room and laboratory, but also to pave the way for bringing into sympathetic understanding the workers in widely separated fields of botanical activity. The causes underlying the development of this new conception, which in brief is the recognition of the fact that botany may be utilitarian and still be botany—may be reduced to two, one of which is economic, and the other social.

The economic cause is to be found in the tremendous expansion of technological enterprises which is characteristic of this industrial age. Developments in the field of agriculture have created a demand for men who have been trained to deal with plants in their practical aspects. Trade and industry have recognized the value of the aid which is to be had from science, and have fostered schools for education along technical lines. In response to the demands of technology, many scientific workers have directed their attentions to practical problems, and one result of their combined labors is seen in the change of point of view with respect to botany, and the wider recognition of its utilitarian phases.

The existence of what I have called the social cause, as well as the part which it has played in reshaping the conception of the proper sphere of botany, may not be readily granted, but its absolute denial would certainly impugn the motives of many of the most devoted and conscientious workers in this field of science. This cause had its origin in the fuller realization and clearer perception of the social obligations of botanists. By social obligation is not meant the friendly association with fellow-workers, or the attendance on dinners, and dances, or afternoon receptions, but the obligation of the botanist, as a botanist, to society as a whole.

So long as botanists were economically independent, or so long as they found it necessary to rely upon some regular profession for a livelihood and devoted only their leisure hours to the acquiring of knowledge regarding plants, they could justly be held accountable only to themselves for the nature and direction of their studies. But as economic development advanced, and division of labor became more pronounced, many people of leisure and culture found it necessary to devote their attention almost exclusively to their business affairs, and the number of professional botanists of independent means became absurdly small in comparison with the number of those who received compensation for their services. For society, recognizing that education along broad and liberal lines was of paramount importance in the upbuilding and perpetuation of our social institutions, has endowed professorial chairs, built commodious structures and supplied the means for securing the extensive equipment necessary for the prosecution of research and the giving of instruction as well as for the support of the teachers and investigators. Thus the economic status of the botanist changed and brought about a corresponding modification in his social obligations, which in turn led to a broader appreciation of the significance of service. Whoever accepts support from another, be that other an individual or society as a whole, does so either upon the basis of charity or upon the condition of giving an equitable return in service rendered. There is no one worthy of the name of botanist who does not scorn the former, and perhaps none who is not satisfied that he is meeting the latter condition. But who is to be the arbiter as to the equitableness or character of the service rendered? The botanist? Yes, if he is deeply imbued with a right sense of his obligation to society, but if not, if he is one of those who mistake knowledge for an end itself instead of a means to the broadening and energizing of human existence, society will sooner or later relegate him to the place now occupied by the astrologer and the alchemist. Society then has the right to demand, and it is the obligation of the botanist to render service that has a distinct and plainly discernible economic or social value. This does not mean that botanists should con-

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sider plants only from the industrial point of view, but it does require the abandonment of the dogmatic attitude which has so long been hostile to any union of philosophical interest and industrial needs. It means the obliteration of the class line between the nobility of wild growing plants and the bourgeoisie of cultivated species; it means the recognition and acknowledgment by teachers and investigators that very practical and commonplace subjects, such, for example, as the germination of ordinary garden seeds, often present as profound theoretical problems as those which are far removed from the field of possible utility; it means the recognition of the principle aptly stated by a recent writer in another connection that "It is the interaction of various types of human thought and investigation, and not mutual isolation or contempt, which helps us all, while he does best who works with the profoundest theoretical problems and the most intensely practical interests at once pressing upon him, with the widest and most philosophical breadth of view, and the most faithful special labor, at once demanding attention."[2]

The socialization of industry and the specialization of almost every line of human endeavor has necessitated fundamental changes in the spirit and methods of education. No longer is the hope held out that more than a fraction of the students that fill our schools and colleges can win a competence in the learned professions, and large numbers must be encouraged to look for their life work in some line of activity closely associated with industry. To such of these as may choose an occupation in which practical knowledge concerning plants will be of benefit, the social obligation of the botanist is clear. He should encourage rather than discountenance investigations of a very practical nature, relying upon his own endowment with the true scientific spirit to so shape and direct the work of his students that it may lead to the development of the desired scientific attitude of mind toward the fundamental principles of plant life. To be sure it will be objected that in such a course lies the danger that education will become a merchandise and science be degraded into a mere trade. It is feared that the time spent in learning anything which can not be turned into money will come to be considered as lost and that no longer will there be any interest in the search for truth that does not bear the earmark of utility. It seems to me, if there is any danger to the future of botanical science, that it lies in an entirely different direction, that is, in the failure to recognize the great possibilities for the development and stimulation of widespread interest in the more theoretical aspects of this subject, growing out of its relation to the material affairs of men in general, for just as our social workers have learned that religion offers poor comfort to the man whose stomach is empty, and whose body is imperfectly clothed, so botanists must come to see that their philosophy will mean little or nothing to the great mass of society unless it finds some expression along lines of human interest and necessity.

It is a social obligation of the botanist to insist that the standards by which he is to be judged shall be those of personal value rather than the standards of wealth. Measured by the latter, his position in the economic scale may be regarded as comparable with that of the wage-earner or his fellow worker in the trades, whose usefulness to society is largely measured by his ability to adapt himself to the material and often mechanical requirements under which he must perform his task. The usefulness

[2] Royce, J., Science, N. S., Vol. 38, 1913, p. 584.

of the botanist, however, can not be so measured, for the service which he renders to society is of an order entirely different from that of the craftsman. His work is to explore the boundaries of knowledge in his search for additional truth, to break the bonds of tradition and opinion when they fetter progress in the solution of scientific problems, and through creative thought to advance the science of botany and its useful applications. The value of his service is not necessarily conditioned by his salary, his degrees, his hours of work or the number of his printed pages, but it does depend, in part at least, upon his open-mindedness to truth, upon his ability to direct his efforts along productive lines, upon the validity of the conclusions based upon his researches, upon the contribution which his discoveries make to social welfare, and upon his power to inspire and right to retain public confidence in the value of botanical investigations. Through his deep sense of community of interest and the recognition that his studies may be of service to all mankind, he thus places himself beyond the pale of economic class distinctions, and is entitled to be judged solely by his personal value.

Nevertheless, botanists themselves have a tendency to judge each other by standards which fall far short of those of personal value. Too often is the sign accepted at par value when the thing signified is only debased currency. An array of scholastic degrees and a long list of titles of published articles may gain for the fortunate possessor a recognition wholly disproportionate to the service he is rendering either to science or to society. The much-deplored tendency to "rush into print" on slight provocation or on no provocation at all, and the frequent occurrence of the legend "Read by title" in the proceedings of our societies and associations, is at least presumptive evidence that judicious advertising is not without its reward to the individual irrespective of any other results that may follow. The objection which may here be made, that men who are widely separated can come to know each other's work only through their respective publications, answers itself, for the argument is entirely against setting up as standards of measurement, degrees, instead of the personal value to society of the man bearing the degree, and against regarding titles of publications rather than the merits of the publications themselves.

When scientific men overestimate the importance of its symbols to the neglect of achievement itself they give hostages into the hands of those who seem to think that scientific activity can be measured according to some fixed standard, and its value expressed in numerical terms. They also limit and restrict their usefulness to society when too much account is taken of those personal distinctions which are often made between workers in different lines of scientific activity and sometimes between those in lines which are closely related. It is necessary to emphasize the standard of personal value and to insist that a clear distinction be made between the nature of the task of the scientist and that of the industrial worker if the former is to remain free from checks and hindrances which are incompatible with true scientific progress, and if he is to be awarded recognition on the basis of his real contribution to the progress of civilization.

It is a social obligation of the botanist to be a man of affairs. The outlook for the future is that the bond between scientific investigation in botany and economic work will become closer and stronger, and that botany, already occupying an important place in the applied sciences and in human affairs, will gain even wider recog-

nition as one of the permanent forces underlying social progress and activity. Time will bring greater and more insistent demands for the extension of inquiry into every field where the application of the fundamental laws and principles developed through the scientific study of botany promises to minister to the needs of humanity. The organization and direction of the botanical work of the immediate future, in a manner that will preserve the proper balance and correlation between scientific research of the broadest and most fundamental character, and investigations undertaken largely or entirely for economic ends can be successfully accomplished by men who are not only broadly trained botanists, but who are men of affairs, as well.

Scientific progress is not accomplished by the mere accumulation of knowledge, but follows only when knowledge is communicated and brought within the grasp of all who are able to utilize it in any phase of human endeavor. The rapidity with which new knowledge makes its way and the extent to which it finds ready acceptance and assimilation depends upon the terms in which it is formulated, upon the clearness and thoroughness with which its relationship to other forms of knowledge is presented, and upon the number and variety of its possible applications which may be pointed out. Manifestly, he who will succeed best not only in securing the fullest appreciation and utilization of the results of his work, but also in obtaining merited personal recognition for his services, is he who retains a broad and liberal point of view with respect to the related branches of his science, and who is able to put himself into sympathetic relations with men who differ widely in interest and activity.

The scientific worker who would remain in the most active lines of modern progress, and who appreciates the disappointments and discouragements that often fall to the lot of one who has failed to keep in sympathetic relations with the spirit and purpose of the age in which he lives, will find it desirable not only to acquaint himself with developments in lines of scientific investigation widely separated from his own, but also to extend the scope of his mental horizon until he can obtain a clear view of the readjustments and changes which are constantly taking place in the domains of industry and education and in the fields of political and social affairs. The idea here expressed may be regarded as wholly fatuous and incapable of realization, but the fact remains that specialization alone will lead to a dendritic or tree-like development of science, which instead of conducing to general progress, will ultimately operate as a hindrance to it. Indeed, the development of a science is in many respects analogous to the evolution of a species of organisms, for just as the latter make evolutionary progress (I here quote a well-known writer on organic evolution) only through being "connected with each other by an intricate network of descent in the weaving of which the diversities of the members of a species have a definite physiological value," so will a science approximate the maximum limit to its capacity for progress only through the continuous interaction of the ideas and the integration of the principles developed in its various phases and aspects.

It is a social obligation of the botanist to study processes, to penetrate more deeply into the mighty forces of organic nature to the end that they may be brought more completely under the control and direction of man. The satisfaction of human wants is in a large degree dependent upon processes which have been slowly built up by plants through countless ages of

gradual development, and since the laws governing them are not sufficiently well understood, these processes have played a small part in the advancement of industry. We have no choice, for the most part, but to accept such products as the plant may yield, instead of being able either to fully control its activities, or having discovered the secret of its processes, to utilize them in the direct production of desired materials. The problems here involved are fundamental in character and can be solved only by scientific research of the highest order. It is not a question of applied science, but a search for the underlying principles which may lead to a full understanding of the functioning of plants, and the scientific worker who achieves success in this field will not only make a noteworthy contribution to science itself, but will also make possible profound and advantageous changes in the world of industrial affairs.

No less important than the investigation of the processes of plants themselves is the study of the processes by which they have come to be what they are. In this lies one of the most fundamental problems of modern botany, a problem which involves no less than the ultimate elucidation of the laws which have determined the evolution of the vegetable kingdom. The successful solution of this problem promises results of profound significance, and advanced workers in this line of botanical activity have predicted that the time is almost at hand when our present system of classifying plants will be supplanted through "the discovery of a system which shall depict plants in their evolutionary sequence."

The botany of the future will be more and more concerned with a study of the very recent stages in the descent of the living flora, and there can be no doubt that this line of research will be greatly stimulated by economic considerations. The efforts to bring under control those processes by means of which improved species or varieties may be originated, will lead to a much wider study of plants, and to a critical study of their relatives from widely separated situations. In arboretums and botanic gardens as well as in the great herbariums there will be brought together collections of materials for use in the investigation of genetic relationships. For the future, it is not too much to hope or expect that in proportion as our knowledge of these relationships increases corresponding advances will be made toward a solution of some of the complex problems of evolution and heredity.

It is a social obligation of the botanist to be efficient. Stein[3] in his brilliant work on the philosophy of society observes that "The sense of obligation can never be derived from biology." It would seem to be self-evident that the complex facts of human life and experience can not be rightly interpreted by the same natural laws which govern the growth and development of a biological organism, although the latter view has not been without its exponents and followers. But public opinion, though long suffering, can not be depended upon to forever countenance those scientific workers whose attitude toward society is expressed by the old doctrine, "mind your own business," and whose rule of conduct recognizes no influence or appeal that lies beyond the limits of their science. The service of highest efficiency, however, will be rendered by those who through experiment, observation and generalization, succeed in dispelling the mists of shadowy suggestion which have prevented a clear view of many facts of nature, and who at

[3] Stein, "Die soziale Frage im Lichte der Philosophie," 1897, s. 222.

the same time prepare the way for their widest application and utilization.

The efficiency of the scientific worker bears a very direct relation to the motives which guide him in his work. The temptation to follow the line of thought or study that for the time appears most attractive is very great and for some irresistible, and advance in one direction proceeds only until a new and more inviting path is crossed, but the scientist who pursues such a wavering course is apt to be like the aeronaut, very much in the air. The most effective workers are those who have the greatest power of sticking to a subject until every means of forcing the truth to reveal itself has been exhausted. As the necessity increases for a general attack upon the more difficult and fundamental problems, the greater is the demand for patience and perserverance in the prosecution of investigation. The homely, but expressive saying, "It's dogged as does it," which was often quoted by Darwin, illustrates a mental characteristic which has led many a man to overcome apparently insurmountable difficulties.

It is also easy to fall into the error of assuming that the collection of data is science and that whoever actively and industriously accumulates a large collection of observations on various natural phenomena thereby contributes largely to scientific progress. But the application of thought in lines that lead to definite and tangible results, and the collection of data to some useful purpose, "will always have as their guiding motive the testing of some tentative hypothesis needed for the explanation of our experience." The shelves of our libraries bear many a musty tome in which are recorded countless observations on the phenomena presented by plants, but many of these observations have little meaning for science to-day either because they were not made with sufficient discriminating care and precision to give them scientific accuracy, or because they lacked the correlation with well established facts necessary to their interpretation in harmony with later discoveries. Other observations have remained in oblivion or conscious neglect, either because of the accident of their place of publication or because they did not appear in one of the "recognized" mediums of scientific utterance. It seems reasonable to assume that the scientific accuracy or validity of published observations or conclusions depends upon the efficiency of their author rather than upon the place of publication. Those who regard a restricted group of books and journals as a canon to which alone they look for authentic scientific utterance, and regard all others as apochryphal do but perpetuate the ancient schism between the botanists, on the one hand, and the gardeners and horticulturists on the other.

Efficiency implies not only a wide knowledge of facts, but also a breadth of view which will enable the relations between various categories of facts to be seen clearly. How the lack of understanding of the known phenomena and facts may operate to retard the diffusion of knowledge is well illustrated by the failure of contemporary scientists to understand and accept the discoveries of the early plant breeders. While the gardeners were making discoveries the importance of which was not recognized until nearly a century later, the real scientists were occupied with the recognition and classification of species. The failure of botanists to give credence to the early investigations in plant breeding has been variously explained, but we may well accept the view of Focke[4] that "these discoveries did not fit into the idea of nature then

[4] Focke, W. O., "Die Pflanzen-Mischlinge," 1881, s. 433.

current, for they could not be reconciled with the known facts and therefore were disregarded."

The obligation to be efficient in the avoidance of error is by no means to be taken lightly. The young writer who excused his carelessness of statement and inaccuracy of citation by saying "everybody makes mistakes" no doubt uttered a truism, but he also displayed his profound ignorance of the difficulty with which a misstatement is rectified when once it has gained a footing in literature. There is perhaps no more striking example of the strange fabric that may be woven with the warp of truth and the weft of oversight or error, than the biological principle known as Von Baer's law.

Von Baer is renowned as the originator of the theory that the embryo of every higher animal during its development passes through successive stages in which it simulates the adult forms of the lower animals in the same phylogenetic series. But Von Baer did not originate this theory, indeed he was its most vigorous opponent. What he really taught was that the embryos of different animals are similar to each other in that they adhere to the same plan of development, but through the failure of some of his contemporaries to be precise and discriminating, the ideas of another man were mistaken for those of Von Baer, and the latter was thereby placed in a false light in respect to the contribution which he made to science.

Manifestly a high degree of efficiency is just as desirable in interpreting and citing the writings of other workers, as it is necessary in planning and successfully conducting the work of experimentation, and the scientific worker who renders the best service both to himself and to his science will be as zealous in avoiding the perpetuation of error as he is ardent in his search for truth.

It is a social obligation of the botanist to strive for a better organization of his science. It is not my intention to raise that much-discussed question "What is botany?" the answers to which are approximately as numerous as those who are or who think themselves botanists, although I deprecate the contrariety of opinion which exists with respect to what may properly be included in the domain of this science. Some maintain the old distinction between pure and applied science, and would exclude from the science of botany such subjects as plant breeding, economic botany and plant pathology; others think botany is largely an applied science, consisting in part of mere applications of other sciences; some conceive the science as largely restricted to one of its phases, as, taxonomy, morphology or physiology; and still others maintain that botany is not a single science but a group of distinct sciences with nothing in common except the fact that they are concerned with the phenomena presented by plants.

Segregation and specialization in various lines of botanical activity seem to be a natural process necessarily attendant upon scientific progress. Competition between these lines, each of which seeks to gain the ascendency, and to become recognized as the true representative of the science, also seems not only natural, but necessary to normal and progressive development. There exists, however, a sufficiently close analogy between the evolution of a science and certain phases of organic development to justify the consideration of a well-established biological principle in discussions of the relative importance of different branches of the science, or the promise which they hold out of contributing most to its advancement. This prin-

ciple states that "the point of departure of the progressive lines of one period of time has not been from the terminal types of the lines of preceding ages, but from points farther back in the series." The evidence is not wanting that the new and progressive lines of botanical activity do not originate directly from the most highly specialized branches of the science, but from the more unspecialized portion. Thus arose ecology, pathology and genetics, and so doubtless will the future see the origin and development of other important and vigorous branches of this science.

It seems inevitable that from time to time each branch of the science will pass through eras of reconstruction unless, indeed, "it is assumed that the existing order is a closed system within which men can and should rationalize their conclusions, but only within that system and ever under its authority." But such a philosophy is incompatible with the modern spirit of progress, which is constantly utilizing accumulated experience in the development of new points of view and demanding a frequent readjustment of the relations existing between allied lines of investigation. The organization of the science, however, implies much more than the harmonious adjustment of relations between its various branches, or agreement as to their proper sphere of activity. It requires that botanists realize that their duties are not fulfilled by investigation alone, but that there is also incumbent upon them the obligation to give serious consideration to what for want of a better term may be called the business affairs of the science. If the great body of investigational work now in progress is to have continued growth and opportunity for unrestricted expansion, the means must be forthcoming to provide for its support, and to assure the protection of its interests. Society must be looked to as the source of these means, and how freely they are given and what restrictions or limitations are imposed with respect to the manner in which they are to be applied will depend largely upon the degree to which there is developed in the public at large a sympathetic appreciation of the aim and purpose of the science of botany.

It is relatively easy to obtain financial support for a scientific enterprise which promises speedy returns in kind, but when the energy expended in such an enterprise is devoted solely to securing showy and immediately practical results, then does scientific education become a mere matter of merchandise and science itself is degraded to the level of a trade. Public support to scientific enterprise must be secured on some other basis than that of annual dividends. Results of great and permanent benefit to society may rightfully be expected, but they must be looked for in the better understanding of the forces of nature and their application to the promotion of human welfare, in the development of constructive habits of thought, which tends to forecast the future by an analysis of the facts of the present, and in the social progress which will be favored by a clearer perception of the relations existing between plants and man.

It is fruitless merely to affirm that more attention should be given to the claims of science, or to condemn the non-scientific classes for estimating the importance of scientific work according to its money value. I am persuaded that the much-deplored tendency to look for immediate and practical returns from scientific work is due less to crass and sordid motives than to a lack of right understanding of the manifold ways in which science exerts a beneficent influence upon the affairs of men. This disability, however, is not beyond remedy, and will be much less in evidence

when greater attention is given to the education of the individual along lines which will lead to a better perception of the real meaning of science. Organization and unity of spirit and purpose directed to the scientific education of the public are essential if practical men are to be brought to see that their interests will be furthered by encouraging scientific work and if society is to be depended upon for its liberal support.

Finally, it is an obligation of the botanist to recognize the beneficent influence of personal association. The inspiration gained by participation in the annual meetings of our scientific societies and associations is too well appreciated to need elaboration or comment. Similarly, the importance of the close personal relation between the student beginning research and his instructor is clearly understood. But it is of the possibilities which lie in the closer personal association between the junior and the senior members of this society that I would speak. It is sometimes said that the younger generation is inclined to be dogmatic, self-sufficient and somewhat disregardful of the wisdom and knowledge acquired by their elders. If this be true, it is largely because the printed page has been substituted for the more natural means of communication between individuals. But the printed page transmits very imperfectly the intangible something we call personality, that power to kindle in others the fire of enthusiasm, to develop that point of view which leads to creative thinking, and to point the path to that insight and vision which has been attained by those of riper wisdom. The younger generation needs the personal inspiration and guidance which it is within the power of their elders to give, nay, more, they stand alert and expectant awaiting the time when their natural leaders may signify their willingness to give them counsel and instruction. When the senior members of this society raise the banner of wisdom and experience, and sound the assembly call, they will find their juniors quick to desert the paths which, like those in a woods, end nowhere, or which lead over the heights of purely intellectual gratification, or through the picturesque valleys of individualism, and, rallying to their standard, be content to march together along the broad road of cooperation, and united effort, which ultimately leads to the heights of progress. And then when our leaders shall approach the end of life's journey, they will have the satisfaction of knowing that although their printed works may soon be superseded or sink into oblivion, the influence of their inspiration and personality, perpetuated through their friends and fellow-workers, will endure for all time.

W. W. STOCKBERGER
U. S. DEPARTMENT OF AGRICULTURE

PREMEDICAL EDUCATION

IN Cincinnati on January 17, 1914, a conference was held under the auspices of the faculty of medicine of the University of Cincinnati. Representatives of many medical colleges and of academic institutions had been invited to be present at the meeting and to participate in the discussion upon what has been called, very widely, "premedical education." The object of this conference was to draw together the academic and medical institutions for the sake of more satisfactory preparation of students for medicine.

In opening the conference the chairman spoke as follows:

> In a lecture to his students in 1821, Dr. Graves said that the practise of medicine can not be taught or learned by hearsay. Later in his introductory lecture at the opening of the session of 1837–38 he enlarged upon his former remarks, and said: "No profession requires a sounder preliminary education than ours, and in none ought education to be more studiously directed to promote

the activity and development of the mental powers, especially those connected with the habit of observation as well as with the judgment and memory.'' Dr. Graves realized the importance of individual judgment which must be based upon trained observation, and the dangers of the memory method which is always founded on authority. He was interested in premedical education.

This conference has been arranged for the purpose of centering your attention upon the problems of medical education, and especially of premedical education. It is evident to those of us who are medical teachers that if we are to keep medicine what it is said to be and what often it is not—one of the learned professions—we must have the assistance and the active cooperation of the colleges of liberal arts and sciences. It is to the colleges of arts and sciences that we must look for sound preliminary education for medicine.

For exercise and development of the powers of observation the sciences, physics, chemistry and biology, are most important. The laws of these are constantly applied during the whole life of the physician. Without them the study and practise of physic becomes an affair of memory instead of being one of reason. More and more the problems of medicine are coming to be chemical problems—biochemical, if you please. Biochemistry is the chemistry of the tissues and fluids of the body. These materials belong to that comparatively new class which we call colloids which are investigated most satisfactorily by physico-chemical methods. Physics and chemistry are therefore the basis of the study of the phenomena of life. There is not room in the medical curriculum for these subjects. They must belong in the premedical years—to the courses in colleges of arts and sciences, and in such colleges they must be thoroughly studied in laboratory courses. They can not be studied in lecture courses. We therefore wish to discuss the matter of satisfactory courses in physics, chemistry and biology.

It is almost unnecessary to say that with this science training, language work should not be neglected. This is especially true of English. Many of our otherwise well-trained students are deplorably ignorant of their own language. They need German and French, to be sure, but they need to be able to use their mother tongue. We wish to discuss the matter of English, German and French.

So much for the subject matter of premedical courses.

The quality of the students is just as important. The medical schools of the first grade are interested in teaching a few good students, not in teaching large classes. The United States is already overstocked with doctors. It needs no more physicians, but it needs better ones. The influence of these facts is shown already in the attempts of certain schools to limit the number of students in their classes. With good students in small classes we expect to obtain better results than we could possibly expect even with good students in large classes. Mass teaching is never successful.

Small classes of good students in medical schools will be useful in another direction. The teaching will improve. The colleges of arts and sciences can affect the character of medical teaching by sending only well-prepared students to medical schools. Good students are critical and teachers are very susceptible to criticism.

So, for the good of both colleges of arts and sciences and of medical colleges, a cooperative arrangement should have the greatest value, and such an arrangement should ultimately affect to a considerable extent the whole medical profession and, through it, the general public.

There is another important aspect in this proposed closer association of medical schools and colleges of arts. You know that, as a rule, the state standards for practise tend to lag behind—to be influenced by medical schools of the lower grades. If the colleges of arts will let it be known to their students that without two specified premedical years in college science they can not practise in the Dakotas, in Iowa, in Minnesota, Colorado, Indiana or Kentucky—that is to say that certain states will not consider them sufficiently well-educated to practise—the colleges themselves will be benefited; the medical schools will be helped; the schools of a low grade will be embarrassed, and the state boards will be stimulated to be more active in enforcing standards which will make it more possible to protect the public from the half-educated doctor.

I hope that at this conference we may be able to come to some understanding which will make it possible for us all, and for others who are not here to-day, to work toward the ends which I have suggested. It is for the benefit of all the people that we are working. The people are subject to ill-prepared doctors; they are preyed upon by quacks and charlatans. ''The higher the standards of education in a profession, the less marked will be the charlatanism.''

Following these remarks a series of short prepared papers were devoted to the methods

used and the scope of "premedical" courses in biology (Professor Guyer, of Wisconsin), in chemistry (Professor Jones, of Cincinnati), in physics (President Ayres, of Tennessee) and in modern languages (Professor Brandon, of Miami). Following these papers the meeting was opened for general discussion in which many members of the conference took part.

The gist of the discussion appeared to be that certain preliminary work was necessary for medicine, and that certain other preliminary work was advisable. Furthermore, it seemed that the necessary work should lie in biology, physics, chemistry and a modern language, preferably German; that a substantial enough knowledge of these sciences could not be acquired in a single premedical year; and that while it might be acquired in two years of college work, no time was allowed in a two-year course for various studies, such as psychology, logic, economics and other advisable subjects. Also, it was said that even at the present time the average age of graduation in medicine was about 27.5 years, and that there was evidence of wasted time somewhere. Again it was urged by some members of the conference that a sharp uniformity of preparation was not a wise thing to accomplish, but that some latitude should be allowed in preparation, provided only that students who intend entering upon the study of medicine should be well equipped with a working knowledge of the fundamental sciences, and enough of the humanities to insure breadth.

Before adjournment a resolution was adopted and sent to every college represented at the conference. Later other colleges and even a few individuals were included in the list. The resolution follows:

In view of the ideas expressed in this conference,

Be it Resolved, That the representatives of the various colleges confer with their respective faculties to ascertain:

1. What courses of a premedical nature are offered by them in chemistry, physics, biology and languages.

2. What changes, if necessary, can be made to establish uniformity of essentials in premedical training.

3. Whether it is possible to reduce the total time now required to obtain the M.D. degree, by eliminating duplication of work existing in graded schools, high schools, colleges and medical schools. Your committee is of the opinion that this is feasible.

4. What arrangements are made for granting the bachelor's degree after satisfactory completion of two or three years' college work and one or two years in a Class A plus medical school, and,

Be It Further Resolved, That the action taken by the various faculties be reported to Paul G. Woolley, University of Cincinnati, chairman of the general conference committee, for tabulation, and that this committee may, at its discretion, call another general conference of the colleges interested in this movement.

(Signed) M. F. GUYER, *Chairman,*
HARRY H. HOLMES,
LAUDER W. JONES,
HENRY MCE. KNOWER,
E. L. RICE

By the time that the resolution was ready to be mailed a communication had been received from Professor Holmes, of Earlham College, which it seemed might furnish an excellent basis for faculty and departmental discussion. Accordingly, Professor Holmes's letter was embodied in a communication sent to each college. This letter was as follows:

My Dear Sir: The following remarks have come from Professor Holmes, of Earlham College, who was a member of the Cincinnati Conference on Premedical Education. It seems to me that these suggestions furnish a very thorough basis for the discussion of Premedical Courses in Colleges of Arts and Sciences.

"I want to suggest that our committee (or yours) map out a fairly definite three years' course of college work and persuade a large number of colleges to grant the degree of B.S. or A.B. on the satisfactory completion of this and one year's work in a 'Class A Plus' medical school. It does not meet the situation to arrange this unless nearly all the work is rather strictly outlined. Three years of general elective work could be a very poor preparation for medicine and the whole effect could be a hodge-podge not deserving the A.B. or B.S. degree. We must have a consistent major *medical and premedical,* for this period.

"The present 'Class A Plus' requirements of only two years college work, even though certain needed subjects are specified, cuts short the foun-

dation of chemistry so desperately needed in medicine, permits of but one modern language (because of limited time), and yet both German and French are required at Johns Hopkins and needed everywhere, and if the student attempts to take both chemistry and biology during these two years he can carry physics only at the expense of loading with three sciences at the same time—questionable in college. This plan doesn't allow for general culture.

"How much better to have the student of medicine splendidly prepared in all the fundamental essentials of his profession by three years in a college atmosphere with a little time for broader culture. Many who are not willing to spend four years for a college degree or three years as indicated would do so if they were to be rewarded with such a degree after the first year in the medical school. The standard of medicine would be raised and colleges themselves hold their students longer than at present. A few who now take four years might stop with only three, but this would be more than made up by the two-year students who remain for three years.

"Of course the state universities and some others have an arrangement for granting the B.S. to *their own men* after three years in college courses and one in their own medical school but what we need is a uniform standard for a large number of colleges, a standard that forces full training in the essentials. We save a year and gain much.

"Since I am not a biologist, I leave the details of that subject to be filled in by the rest of you. The laboratory time is measured, not by any credit system, for that varies, but by actual required periods of work. The electives possible should not be permitted in science or mathematics. This insures a broader training. If we get a score or more colleges to agree to this arrangement we may persuade the American Medical Association to publish a list of 'Class A Plus Pre-medical Colleges.' Why not?"

The following is Professor Holmes's schedule of the three years' work:

FIRST YEAR

Chemistry, General:—At least 72 hours of lectures. At least 144 hours of laboratory.

Physics:—Same as chemistry.

German:—At least 144 lectures.

Mathematics:—Algebra and trigonometry, at least 72 hours.

Rhetoric:—At least 72 hours.

SECOND YEAR

Chemistry:—Must include some qualitative and quantitative analysis. At least 72 lectures and 144 hours laboratory.

Biology:—Similar to chemistry.

German:—At least 108 lectures.

Elective:—108 hours outside science and mathematics.

THIRD YEAR

Chemistry:—Must include organic: lectures, 72; laboratory, 96 hours; any other chemistry laboratory, 48 hours.

Biology:—Similar to chemistry.

French:—144 hours.

Elective:—108 hours outside science and mathematics group.

Note.—Hours refer to the entire year. The above is merely the minimum and in many cases could be increased slightly.

The results of the correspondence are interesting, not so much because so many institutions responded, as on account of the nature of the responses. As is usual in such instances those who were really interested continued the discussion, the uninterested dropped it. This again is of interest because evidently from the letters, there are some very much needed reforms.

One institution took faculty action on the resolution, and returned the following:

Be it resolved, etc.,

1. That we are glad, in so far as it is possible, to arrange our courses in biology, chemistry and physics so as to meet the admission requirements of the best medical colleges. That we are now doing this is evident from the fact that our graduates are readily admitted to the medical school of Johns Hopkins University.

2. That we will cooperate with the medical schools in every way practicable to eliminate duplication of work in college and medical school whenever such duplication exists.

3. That we do not regard a year in a medical school as having the same purpose or being in any sense equivalent to the senior year in college; that we regard the two fields of education as essentially different and distinct. We are therefore opposed to any plan whereby the bachelor's degree shall be given upon the completion of less than four years of college work.

One would only remark in commenting upon

this resolution that it all depends upon what the senior year is devoted to, whether it is or is not equivalent to a year in medical school. The senior year at Purdue in the course leading to the "B.S. in Science" is the equivalent of a medical college year and not "essentially different or distinct." Also, one might suggest that the meaning of equivalent should be stated if the paragraph is to be forceful. Moreover we shall point out later, the main difficulty in duplication is not between college and medical schools, but between college and high schools.

Other responses have come from presidents of institutions. Between these there is a world of difference. One is as follows:

> The National Educational Association has a committee out on this question [reform of the whole system of public schools]. It would be undesirable for the medical schools to take any definite action in conflict with the recommendations of this committee, or with the action of the N. E. A. I think that the best we can do at the present time is to accept the public school system as it is and build on it. Referring to the recommendations of Professor Holmes, of Earlham College, I beg to say that I do not believe that it is desirable to attempt to tie down colleges as to the character of their work for their degrees; I think the colleges would resent any attempt to impose such uniformity on them. I think, further, that the consensus of opinion at our conference, including the opinion of Dr. Welch, was that such stereotyped uniformity was undesirable. No two men would probably agree on exactly the relative distribution of time between the various subjects, or on the most desirable choice of subjects themselves. I, therefore, think it will be wise to keep out of the way of such complications and difficulties that would beset us if we attempted such uniformity.

The writer of this letter misunderstands Professor Holmes schedule, which was suggested as the form of a course. In carrying out such a scheme no limit is placed upon the individuality of teacher or student. The "relative distribution" of time is one thing, the essentials of premedical teaching is another. There is a *least* time in which the essentials can be covered by the average student and the schedule is made for the average. Allowance is always, I hope, made in colleges at least for the brilliant students for whom no schedule can ever be made.

Another presidential letter follows:

> I will answer first the questions formulated by your committee.
>
> 1. We offer everything required in the regular premedical course, that is, we fulfill the two-year requirements of the American Medical Association and besides this have just adopted an agreement with Western Reserve Medical College for a combination course—three years at our own school and four years at Cleveland.
>
> 2. I believe that the only way in which uniformity of essentials in premedical training can be obtained is by the adoption by the American Medical Association of standard requirements for a three-year course. Our faculty believes that the course suggested by Professor Holmes, of Earlham College, is an excellent one with possibly one or two minor additions. We are, at present, giving everything in this course and should be glad to publish in our catalogue a regular three-year premedical course if sanctioned by the Medical Association.
>
> 3. Our faculty believes that duplication of work is practically unavoidable in view of the quality of teaching done in certain secondary schools in the country. We believe that the best way to get efficient teaching in these schools so that work done there need not be duplicated in college is to increase considerably the requirements for those who wish to teach in such schools. Our idea is that the present system of examination required of teachers in many subjects tends to an unwise dissipation of energy on the part of the candidate. We should advise much stricter requirements in that particular line in which the candidate wishes to teach, with a thorough examination, and, at the same time, elimination of a dozen or more odd subjects now required in Ohio teachers' examinations. We believe that this method would make for the securing of well-prepared specialists in the various departments of secondary schools.
>
> 4. As stated above, we have made formal arrangements for a combination course only with Western Reserve Medical School. We are, however, prepared to enter into the same combination with any school in the A plus class of the American Medical Association. Our requirements are: Three years spent in residence at . . .; the pass-

ing of at least 96 semester hours of work here, with a total of 128 hours for graduation; also the completion of the necessary major and minor requirements in any of the courses laid out in our catalogue. If these conditions be satisfied, we will give a Bachelor's degree to students in combination course after one year's work in an A Plus Medical School.

I proceed now to answer your second letter containing the course of study proposed by Professor Holmes, of Earlham College.

I may say at the outset that our faculty is heartily in sympathy with Professor Holmes's ideas and believes that the establishment of a definite premedical course with a list of approved premedical colleges would be of extreme value.

As stated in answer to your first letter, we are perfectly willing to adopt combination courses giving a college degree after three years spent with us and one year in an A plus medical school, provided that the student has three years of residence in . . .; passes 96 hours of work here and a total of 128 hours for graduation and provided also that he fulfills the major and minor requirements of one of our regular courses. We already have made such an arrangement with the Western Reserve Medical School.

Our faculty begs to signify its approval of a three-year schedule as submitted by Professor Holmes with the following suggestions: That the various colleges be allowed a certain latitude as to the year in which certain subjects are given. Our courses in physics, for instance, are not open to freshmen and could not be taken in the first year. Possibly a general statement of requirements in each subject would meet more general approval than a definitely laid out program year by year and would allow various colleges a little more latitude in arranging courses. Our faculty is also unanimous in its feeling that at least 108 semester hours of psychology should be required in every premedical course, since this subject is practically indispensable to a well-equipped medical man of to-day.

With the above suggestions, we are heartily in agreement with the proposed plan and are willing to adopt it should it receive the sanction of the American Medical Association.

In this letter the quality of teaching in the secondary schools is mentioned. This I shall comment upon later. I wish, however, at this point to emphasize the method suggested for improving the teaching ability and therefore the quality of the teaching in secondary schools. The question of psychology is also touched upon. Certainly a course in psychology should be a prerequisite for graduation in medicine. Without it there is little value in courses on mental diseases, but any introductory course should be supplemented later by a brief course in experimental psychology, and, for those who desire to go more deeply into psychiatry, a thorough course should be offered.

Among the letters which have been received, there are two from deans which deserve quoting. The first begins with an outline of the work offered for the degree B.S. It then says:

> We have had one case granted the privilege of being absent during the senior year, counting the work of the medical college as equivalent to our senior work. It did not appeal to us very strongly for several reasons. First, the difficulty of getting the reports of standing at proper times and controlling thesis work. This, of course, was a minor difficulty, but none the less annoying. Second, was the fact that high-grade students are not as a rule interested in such a scheme. With us it has apparently applied to an unstable group of students, restless under university restrictions and apparently constitutionally unable to remain in any institution for more than a year or two. Such men are neither good representatives of the college from which they go nor desirable candidates for the medical college in which they matriculate.
>
> May I suggest another possible solution? Suppose we realize that four years is not a divinely appointed length of time for either baccalaureate or medical degree. Suppose we recognize the fact that the degree represents a definite amount of work satisfactorily done. Suppose that we also allow men of sufficient mental strength, industry and eagerness to do the work in three years, either in the college or in the medical school. If this were done, would not the same, if not a better, result be reached? Certainly high-grade men would be rewarded for their ability and industry and a short cut to two degrees would not be offered to all sorts of candidates. Whether in university or in medical college there seems no good reason why a man should not have one or two ways of obtaining credit, either by taking the subject or by examination.

As it stands, all of our courses of study are arranged for the average man, and the average intellect of five hundred people does not come very high. An easy inference is that many bright men, both in the university and in the medical college, are merely marking time. A method such as I suggest has nothing against it save the sanctity we have thrown around the four-year idea of the amount of work required for a degree. If requirements for a degree were measured in quantity and quality of work, instead of in time, many of the difficulties of which we complain would disappear.

I have no sort of objection to the plan as outlined. It is substantially that put in practise in 1895 by a number of institutions maintaining premedical courses by private arrangement with medical colleges. I will present the communication to the faculty for consideration and action, but I doubt if we would care to advertise a three-year-in-and-one-year-out-degree. That a baccalaureate degree should not be given for work done in absentia is almost a necessity if the degree is protected.

A scheme which will give the man of exceptional ability a chance would appeal to me. At present our educational systems favor the average man and penalize the exceptional man. We spend too much time trying to put a polish on a buckeye which should be given to mahogany. However, count on me to attempt to put anything through the committee agrees upon. I feel it is about time we are getting down to fundamentals in this joint between university and professional schools. If the fundamentals are not such, then what I have said is without significance; but being in close contact with medical and university education makes me absolutely certain that any attempt to shorten the time before the degree of M.D. can be secured, by elimination of English and other cultural studies, is basically wrong and foredoomed to failure.

This letter is to me an exceptionally strong one, for I feel that it hits the nail exactly and evenly on the head. The "divinely appointed length of time" occupied in the various divisions of an individual's educational career needs consideration. Let us by all means measure a man first by the quality of his work, and second by the quantity, and then help him in the way he should go, and if he deserves it, if he is mahogany—polish him; if he is a nut—give him what polish we can spare from the finer work, or plant him in another soil.

The second letter that I wish to quote in this connection is from a medical dean of a university where two courses are offered in preparation for medicine, a one-year and a two-year course, the latter leading with additional medical years to the degree B.S. This letter says that when conditions change, they in that university are prepared to make a rearrangement which will, the dean believes, be an improvement. And further,

> The most serious problems with us arise from the inefficiency of the high schools, especially in the elementary science and language courses. So few of our high schools (and I think the conditions are essentially the same throughout the greater portion of the South) give acceptable courses in science and modern languages that for practical purposes they may be left out of consideration. The result is that the college courses must necessarily be more elementary in character and of lower grade than they otherwise should be. A course in general chemistry, for instance, arranged for students who have had in the high schools an elementary course in general chemistry with laboratory work would be of a much higher grade than a course arranged for students without such preliminary training. So long as this condition exists there will be very little improvement in "chemistry 1" or "zoology 1" or "physics 1." The weak elementary courses strike at the foundations of a sound science training and so long as chemistry 1 is weak, chemistry 2, 3 . . . x will not be all that we expect of them. The problem with us is therefore the strengthening of chemistry 1.
>
> In the absence of adequate high school courses one obvious remedy is the introduction into the college curriculum of a group of elementary science courses supplementary to the high school course. This has been done in the modern language department here. Such an alternative will necessitate an additional "college year" which for many reasons is objectionable. The college should do less rather than more of the high school work.

This letter calls attention to the fact that high schools offer courses in physics, chemistry and biology, and that they offer incomplete courses, which, however valuable they may be to the individual who is not going to study medicine, waste the time of the one who

is going to. The remedy is obvious. The high school should limit its incomplete scientific work for the many who do not expect to follow scientific courses in college, and either offer complete courses for those who do expect to do scientific work, or leave the introductory science to the college. Such a program would mean a certain amount of individual work along the lines of vocational guidance, a thing which is being done more and more in preparation for the trades, and with excellent results. It has not been applied to the professions. As the age of graduation has increased it has become evident that some method must be devised which shall save the time of the student in order that he shall be prepared for his life work before he reaches senility. I have already called attention to a possible method of applying guidance methods to premedical students in high school and grammar school, but so far as I know the experiment has never been made.

There is a method which might be used certainly in college and even in high school. My attention was called to it by my colleague, Professor Fischer, who designated it as the Missouri plan. It is based upon a system which allows a student who does excellent work in a subject additional credit. The following extract from the University of Missouri Bulletin 1913–14 will elucidate the method:

> In order to encourage students to do the best work of which they are capable, the faculties of the college of arts and science and of the school of education credit their work in proportion to the grade received, thus enabling the most industrious students to *graduate in three years.* For each recitation hour for which the grade of excellent is recorded, the student will receive thirty per cent. additional credit. For each recitation hour for which the grade of superior is recorded, he will receive fifteen per cent. additional credit towards graduation.
>
> The faculty further recognizes that those students who are inferior to seventy-five in a hundred, but whose work is not estimated by the teacher as a complete failure, are entitled to some credit. Students will, therefore, be given four fifths of the normal credit towards graduation for each recitation hour for which the grade of inferior is recorded.
>
> In order to do entire justice to the needs of the students coming to the University of Missouri, the faculty adopts the method of instruction to the students of average ability. Those who are of somewhat less ability will thus receive some benefit from the instruction and some credit. Those who are of superior ability and will devote their best energies to their work will accomplish much more than the average student, and will be given for this, not empty honors, but recognition of their accomplishments by additional credit.

There is one letter which attacks the general elective system. In this letter the writer says that he has been opposed to the free elective system. His "contention has been that the undergraduate should be free to select his own aim, such as law, medicine, commerce or engineering; but that we should prescribe the program of work for its attainment." "Your letter," this professor says, "gives one a new incentive for a renewal of the contest; but this time for a three-year program."

Personally I believe in this stand on the subject of electives. I believe there should be a very definite program outlined for each student who has chosen his field—not a time schedule, but a subject schedule—in which there shall be some space for electives. And I believe, as I have said elsewhere,[1] that the earlier in the educational career of a student this schedule can be put in force, the better. There is too much to be known in all professions to waste time in indeterminate grazing.

The letters from professors, all from heads of departments, are as strong as those already quoted. In almost every instance the writers insist upon thoroughness and upon essentials rather than time consumed. Every one insists (though indirectly in certain cases) that three years of college work is the least in which the average man can obtain the essentials of medical preparation and the other things which, while not essential for medical practise, are essential for breadth and wide understanding. It was this thing that I have called breadth which made our fore-

[1] *Lancet-Clinic*, 1914.

runners in medicine what they are to us. Without a wide and deep social vision the doctor of the future will not be what he should be. Medicine is becoming more and more social. Its function is becoming more and more one of prevention. And a deeper insight into human nature, and a keener understanding of all the sciences, particularly the biologic, will be demanded of the man who will succeed.

PAUL G. WOOLLEY

UNIVERSITY OF CINCINNATI

PROFESSOR THEOBALD SMITH AND A NEW OUTLOOK IN ANIMAL PATHOLOGY

THE recent announcement of an additional endowment to the Rockefeller Institute for Medical Research, for the establishment of a department of animal pathology, marks a far-seeing and helpful recognition of the importance of a phase of research now scantily supported, yet full of promise for the physical and economic welfare of mankind and the well-being of animalkind also. But as the success of such an undertaking is after all more a matter of men than of money, the news that the projected department is to be organized and conducted by Professor Theobald Smith, of Harvard University, is of the happiest augury.

Though long in the foremost rank of the notables of science in America, the work of Professor Smith has not often secured, or suffered, popular exposition. But he has had the uncommon satisfaction of seeing, many times, the lines of thought and research which he has opened lead sooner or later to far-reaching theoretical development and practical achievements.

Thus while Dr. Smith was yet a subordinate in the Bureau of Animal Industry in Washington, he had occasion to study the Texas fever of cattle, then the cause of great economic loss to the farmers and cattle-men of that as well as other states, and of countries the world over. He found at last that the disease was incited by a protozoan parasite so small that it found a spacious abode within the purlieus of a single red cell of the blood, which it ruthlessly destroyed.

Smith and Kilborne announced also that this piroplasma, as it was called, is conveyed from animal to animal through the intervention of a cattle tick in which the protozoan undergoes a developmental cycle upon which the perpetuation of its kind depends. They further learned that cattle recovered from the fever had become immune, and though well, might indefinitely carry the piroplasma in the blood and be a perpetual source of infection for cattle fresh from another district.

This surprising, unprecedented, and, as it seemed to many at the time, unnecessarily complex and rather preposterous mode of infection made good its claims, and Texas fever leads the line of infectious diseases in men and animals, in which some insect acts as intermediary host and sole conveyancer of infective microbes from their sources to fresh victims. Thus in malaria and in yellow fever it is the mosquito which is to blame, and its suppression in any country insures virtual emancipation from these diseases. Thus have Cuba and Panama been rescued, and the way is open for the control of other tropical infections in other lands. Thus also the infective agents of plague and typhus and other communicable maladies are harbored and dispersed by insects which are the vulnerable links in the chain of infection often most easily broken through sanitary control.

The story of all these practical achievements in disease prevention through the knowledge and control of insect pests, leads back twenty years and more to the hot and gloomy garret in Washington, then the laboratory of the Bureau of Animal Industry, and to Dr. Smith's parasitic cattle tick harboring its own invisible protozoan parasite. And Texas fever no longer exacts its toll from man or beast; or if it does it is the man's fault. These immune cattle, bearers of the, to them, innocuous parasite, head the procession of "carriers" of infective agents, in which humans are now known to hold a conspicuous place, and are the bugbears of preventive medicine to-day.

Almost as soon as Koch had shown the world how easily and accurately to cultivate bacteria, more than thirty years ago, in the very

earliest of the eighties, the laboratories got intensely busy in the search for new species of germs; and as fast as forms were discovered which incite disease, the knowledge of how they look and what they do and how they may be restrained or destroyed was turned to the service of man and beast.

But the researches were not long content to spy upon the performances of the germs. What the living threatened body does to protect itself against them when once they gain a foothold became a subject of wide and fruitful inquiry. So the facts and doctrines and guesses relating to immunity and to infection, either natural or acquired, came to the front.

Pasteur had got some wonderful results in the experimental conference of immunity to infection, by gradually adapting animals to disease-inciting germs, which were living, but whose virulence and potency had been artificially reduced. It was then supposed that only the subtle action of the living germ could conjure forth the remarkable protective power apparently created in artificial immunity. Many others were at work on these and kindred lines; Dr. Smith among them. But he noticed, and was the first with Salmon to announce in 1886, that animals could be immunized not only by living germs but by cultures of these which had been sterilized and every vestige of life destroyed.

This announcement did not seem to start even a ripple in the bacteriologic pool. But the thing was in the air. There were many busy workers, and sooner or later such a record helps more than is commonly realized another explorer who is heartened to find his pathway not quite untrod.

Very soon it had been shown that immunity to diphtheria may be secured in animals not only by the living germs, but by the sterile products of their life processes. Thus with the names of Loeffler, Behring, Roux, Yersin and many others, opens the story of diphtheria antitoxin and its marvellous benefactions to mankind.

And so again, every horse which is turned to the uses of suffering mortals and gets his dosage of sterile diphtheria culture broth for the manufacture of antitoxin, is but another exemplar of the principle which first crystallized in the light of the response which Dr. Smith's pigeons made to the sterile hog-cholera bacillus cultures, at that early day, close to the dawn of the bacteriologic era in biology and medicine.

Dr. Smith has devoted a great deal of time and energy to the study of diphtheria and other antitoxins, both as professor of comparative pathology at Harvard and as the director of the antitoxine and vaccine laboratories of the Massachusetts State Board of Health. As is the case with most acute observers in these uncharted fields of bacteriology and immunity, he has encountered many striking phenomena which the lore of the time had not satisfactorily classified or accounted for. One of these carries a little story.

When Ehrlich was in this country in 1904, Professor Smith called his attention to the singular fact that guinea-pigs which he was using to test diphtheria antitoxin, sickened and died upon being injected with normal horse serum several weeks after they had been injected with diphtheria antitoxin. Guinea-pigs usually do not mind normal horse serum at all. Such an extraordinary sensitiveness to normal serum, following earlier injections seemed something new and unaccountable, and when Ehrlich got back to Frankfort he gave the problem to Dr. Otto, who labored with it and presently wrote a paper on what—with an attitude of undismay toward stately adjectives that is characteristically German—he called the "Theobald Smithsche Phënomenon." Nowadays the yearly lists of the achievements of research in infection and immunity fairly swarm with studies on "anaphylaxis," a phase of immunity of which Professor Smith's guinea-pigs afforded one of the first recorded examples.

In the early days of bacteriology Dr. Smith called attention to the value of a bent glass tube, closed at one end, such as was already in use by the chemists, for the purpose of cultivating many types of bacteria and studying their biological characters. This is of especial value in the culture and study of the class of

bacteria known as anaerobic, whose activities are intolerant of the presence of oxygen. "Smith's culture tube" has long been held in high esteem in the outfit of the bacterial laboratory.

But as early as 1890, Dr. Smith called attention to the fact that anaerobic bacteria are exacting not only in their relations to oxygen, but in their food requirements also; and he suggested, and proved, that attention to the latter gave promise of important results in the study of this class of germs. He then, and has repeatedly, urged that the addition to the fluid media in the tubes in which such organisms are commonly grown, of small pieces of sterile animal organs, such as the kidney, fulfil the required nutrient conditions. The repeated hint remained practically unheeded for some twenty years. Then through its adoption Noguchi, at the Rockefeller Institute, was able for the first time to cultivate the spirochete which is the inciting agent of syphilis, as well as several others of its class which have hitherto resisted all the wiles and blandishments of the most accomplished bacteriologists, in the framing of the conditions of culture and the tender of food. With these cultures available Noguchi has made practicable and safe a test—the luetin test—for the most subtle and obscure forms of syphilis. Thus the way is now open for the more ready detection of this sinister disease, for the study on a solid basis of the conditions under which it is manifested; how its protean characters are determined; and what rational methods for its cure may be conducted. Similarly, scarcely more than a year ago, Flexner and Noguchi, by an adaptation of Dr. Smith's long ignored suggestion about the food requirements of anaerobes, have been led to the discovery of the nature of the virus of infantile paralysis, isolating it in cultures maintained through many generations and clearing the way toward a hopeful outlook for the prevention and perhaps the cure of this pitiful malady.

One of Professor Smith's striking achievements is the establishment, through long and patient studies, of a type of the tubercle bacillus which has become especially adapted to cattle and now is known as the "bovine type" of the tubercle bacillus. The delimitation of this organism and its differentiation from the human type have made possible a series of exact researches by others on the frequency of the occurrence of the bovine bacillus in man. And thus to-day those who are engaged in the long and stubborn fight against the spread of tuberculosis are on firm ground when they enter the field of meat and milk contamination, to determine the measures which must be taken to safeguard them at their source.

These are some of the landmarks in Dr. Smith's achievements during this quarter of a century of incredible activities on every hand, in the discovery of microbic disease incitants, of the things they do, and the reactions of those individuals of the higher sort who in the vicissitudes of life may become their hosts and their victims.

As the eye ranges over the stately bibliography which marks these years of Dr. Smith's scientific activities, it rests upon many titles with stories in them, of a period or a halting point, in the growing knowledge of disease and its incitants, upon which the author's wide range of thought, his unventuresome sagacity, and breadth of vision have cast helpful and inspiring light.

While Professor Smith gets down to the humdrum details of exact research and record when it is necessary—and it often is necessary in all the ups and downs of the common road of fruitful biological research—the quality which is perhaps most characteristic is the larger view impressed upon all his problems. The biological point of view, if the reader please, in which the individuality of the living thing Dr. Smith sees bears in every feature the marks of its heredity and environment. The tubercle bacillus, for example, is to him not something which has just happened, in the human and animal kind. The bacillus gets his day in court, and is as much a part of the scheme of things as is his more imposing host. What happens when they meet in a many-sided conflict of adaptation, and the problems which gather about it are to be

solved only by sustained attention to all its many aspects.

This larger vision, the ability to set the pace on a high plane, the capacity for work, the power of constructive leadership—these are the qualities which lead those who know Professor Smith and his achievements to rejoice that he is now to center his activities in a field so full of promise as is animal pathology to-day; and this with the opportunities which the Rockefeller Institute affords those who share its aims, to carry forward their chosen work unhurried and unhindered.

T. M. P.

SCIENTIFIC NOTES AND NEWS

Dr. S. J. Metzer, head of the department of physiology and pharmacology of the Rockefeller Institute for Medical Research, has been elected president of the Association of American Physicians in succession to Dr. Simon Flexner.

At its annual meeting, held on May 13, the American Academy of Arts and Sciences voted to award the Rumford Premium to William David Coolidge for his invention of ductile tungsten and its application in the production of radiation.

The Franklin Institute, Philadelphia, on May 20, presented its Elliott Cresson medals to Dr. Edgar Fahs Smith and Dr. Orville Wright. Addresses were made on "Scientists from the Keystone State," by Dr. Edgar Fahs Smith and on "Stability of Aeroplanes," by Dr. Orville Wright.

Honorary degrees are to be conferred by the University of Glasgow on Dr. Archibald Barr, late regius professor of civil engineering and mechanics in the university; Colonel Sir William B. Leishman, F.R.S., professor of pathology in the Royal Army Medical College, and Sir Ernest H. Shackleton.

On May 4, a company of men and women, forest lovers, gathered in Harrisburg, at an informal luncheon, to present a testimonial to Dr. J. T. Rothrock on his retirement from the Pennsylvania Forestry Commission. There were sixty-five present, among whom were Governor J. K. Tener; Mr. John Birkinbine, president of the Pennsylvania Forestry Association; Mr. A. B. Farquhar, president of the Pennsylvania Conservation Association; Mr. J. Horace McFarland, president of the American Civic Association; President H. S. Drinker, of Lehigh University, president of the American Forestry Association; Mr. C. F. Quincy, chairman of the executive committee of the American Forestry Association; Professor J. A. Ferguson, director of the forestry department, Pennsylvania State College; Hon. R. S. Conklin, commissioner of forestry, Pennsylvania, and Dr. S. R. Dixon, state health commissioner of Pennsylvania. The governor presented in behalf of two hundred and fifty donors, a beautiful loving cup, and Mr. Farquhar, Dr. Drinker and Mr. Conklin spoke of Dr. Rothrock's work and personality. Dr. Rothrock spoke feelingly in reply.

At the annual meeting of the Boston Society of Natural History the following officers were elected for the ensuing year: *President,* Charles Sedgwick Minot; *Vice-Presidents,* Robert T. Jackson, Nathaniel T. Kidder, William A. Jeffries; *Secretary,* Glover M. Allen; *Treasurer,* Edward T. Bouvé; *Councillor for two years,* Alfred C. Lane; *Councillor for three years,* Thomas Barbour, Henry B. Bigelow, Miss Cora H. Clarke, William G. Farlow, George H. Parker, John E. Thayer, Charles W. Townsend, William F. Whitney. Reports were made on the work and progress of the year and an illustrated paper was presented by Dr. Hubert Lyman Clark on his experiences as a member of the Carnegie Institution's expedition to Torres Strait and the Great Barrier Reef of Australia. The two annual Walker Prizes, awarded for the best memoirs submitted on subjects in natural history, were voted as follows: a first prize of $60 to Miss Marjorie O'Connell, A.M., of the department of geology, Columbia University, for her essay on "The Habitat of the Eurypterida"; and a second prize of $50 to William J. Crozier, of Cambridge, for his essay on "The sensory reactions of *Holothuria surinamensis.*"

DR. ZENTARO KAWASE, professor of forestry in the University of Tokio, Japan, is in America to make observations in original forest areas, especially those in the southern Appalachian Mountains.

DR. E. L. EKMAN, assistant in the botanical department of the National Museum at Stockholm, recently visited the New York Botanical Garden for nearly two weeks on his way on an exploration for two years to Santo Domingo and the state of Pernambuco, Brazil.

MR. A. N. HALL has been appointed government curator of the ancient monuments of Rhodesia. His headquarters will be at Great Zimbabwe, but he hopes to spend four months of each year in examining or searching for other remains.

DR. A. G. WEBSTER, professor of physics, Clark University, gave on May 8 a lecture on "Sound and Its Measurements," before the Columbia chapter of Sigma Xi.

ON April 23 and 24, Dr. Oscar Riddle, of the Carnegie Institution, lectured before the Sigma Xi Societies of Indiana University and Ohio State University on "The Determination of Sex and Its Experimental Control."

HIRAM PERCY MAXIM lectured on "The Annihilation of Noise" and demonstrated the Maxim silencers before the Middletown Scientific Association at Wesleyan University on May 12.

PROFESSOR CHARLES H. HASKINS, dean of the graduate school of Harvard University, delivered the annual address before the Zeta chapter of Phi Beta Kappa and the student body of Oberlin College, on May 8, on the subject "The Medieval Scholar."

THE retiring president of the Geographic Society of Chicago, Professor Henry C. Cowles, gave on May 8 before the society an illustrated account of his observations and experiences in guiding a party of distinguished plant geographers through the western United States in the summer of 1913.

THE Halley lecture for 1914 will be delivered at the University of Oxford by Colonel C. F. Close, director of the Ordnance Survey, on May 20. Subject, "The Geodesy of the United Kingdom."

THE celebration of the seven hundredth anniversary of the birth of Roger Bacon will be celebrated at the University of Oxford on June 10.

MR. ROBERT KAYE GRAY, an electrical engineer, active in the promotion of scientific research in England, died on April 28, at Brighton, at the age of sixty-two years.

M. PAUL LOUIS TOUSSAINT HEROULT, known for his work with aluminum and the electric furnace, died on May 10, aged forty-one years.

THE Liverpool School of Tropical Medicine plans to establish a permanent laboratory in Sierra Leone for the purpose of carrying on research work.

THE old chateau at Les Eyzies (Dordogne) has been purchased by the French government and will be converted into a museum of prehistoric archeology.

Nature calls attention to an arrangement now established at the Royal Botanic Gardens, Kew, whereby a competent guide accompanies visitors on week days through the gardens and explains the objects of botanical interest. A small charge is made for the services of the guide, 6d. for each person attending a morning tour, and 3d. for each person attending an afternoon tour. The present arrangements are of the nature of an experiment, and their continuance beyond September next will depend on the extent of the public demand for the services of the guide.

WE learn from the *Journal* of the Society of Arts that preliminary steps have been taken for the establishment of an institute of oceanography for the study and exhibition of marine life and products at Ste. Adresse, a suburb of Havre, overlooking the Bay of the Seine. Plans for a handsome building, about 275 feet long and 40 feet wide, have been drawn up by a well-known Paris architect. It will be constructed in a park of 323,000 square feet. It is estimated that the building and equipment will cost about $150,000. It is hoped to have the building completed and opened in time

for the meetings of the scientific congress to be held in Havre in the autumn of 1914. The most interesting feature of the institute will be an aquarium which will offer instruction and entertainment to the inhabitants of Havre and the vicinity, as well as to the numerous tourists who visit the district.

The University of Chicago Press has assumed the American agency for the *Internationale Monatsschrift für Anatomie und Physiologie,* published at Leipzig by Geirg Thieme. Professor Robert R. Bensley, of the department of anatomy in the University of Chicago, has been made American editor of the journal. The University Press has also announced the addition of two journals to the list of nine it publishes in America for the Cambridge University Press, England. The journals are *Annals of Applied Biology* and *The Annuals of the Bolus Herbarium,* the former of interest to workers in entomology, plant disease, diseases of animals, and forestry, and the latter dealing with the flora of South Africa. In addition to these twelve journals of research for which the University of Chicago Press is the American agent, it now publishes itself sixteen other journals.

The department of archeology, Phillips Academy, Andover, Mass., has conducted research work in the state of Maine for a number of years. In June, it is planned to send an expedition of ten or eleven men from the headwaters of the St. John River to its mouth —a distance of over three hundred miles. The expedition will then proceed to the head of Mattawamkeag stream and travel south some fifty miles, and then explore the Upper Grand Lakes, the Lower Grand Lakes and the Ste. Croix basin. A side expedition will move eastward into central New Brunswick. The total distance traveled in canoes will be over six hundred miles. The object of the expedition is, so far as possible, to trace the limits of the so-called Red Paint Culture, and to map prehistoric and historic sites in the regions visited. Excavations will be undertaken where it seems advisable. In case large or important sites are discovered the expedition will work out such in more or less detail, and if necessary, will postpone further reconnaissance until next year. The archeological material discovered, together with observations on historic sites, should enable students to better understand the relationship between the various eastern cultures, and may shed some light on prehistoric migrations. The plans have been approved, and in the absence of the director of the department, Dr. Peabody, in Europe, Curator Moorehead will conduct the expedition. Most of the members of the survey have seen previous service in Maine, and it is hoped that important results will be obtained. Francis B. Manning, of Harvard, will be first assistant; and Ernest Sugden will act as surveyor. The total number of Indian sites mapped by the department in Maine in past years is over two hundred. About 5,300 stone and bone artifacts have been taken from excavations at various points. The department is compiling a bibliography of references to Maine Indians. At present there are over three hundred titles, and the work is not completed.

Dr. J. E. Wallace Wallin, who since the winter of 1912 has occupied the position of professor of clinical psychology and director of the psychoeducational clinic in the school of education of the University of Pittsburgh, has been appointed to the position of director of the psycho-educational clinic in the St. Louis public schools. The clinic will be organized at the beginning of the next school year. It will be located on the grounds of the Harris Teachers College, with which institution it will be closely affiliated. Lecture courses on abnormal children by the director will be offered in the extension division of the college. Students may matriculate in these courses whether or not they reside in the city of St. Louis. The clinic will be organized as an independent bureau in the educational division of the school and not as a minor division of the department of school hygiene or medical inspection. But it will work in close cooperation with the latter department. The clinic will exercise administrative control under the regulations of the superintendent's office over the examination, classification, education,

placing and transfer of the mentally exceptional children in the public schools. The actual supervision of the work in the special classes will be done by a special supervisor working under the direction of the clinic. St. Louis has already segregated about 500 pupils in special classes, and it is expected that the number will now rapidly be increased to at least 1,000. Each child will be given a psychological, sociological, pedagogical, hereditary and medical examination. It is expected that a staff of assistants commensurate with the growing needs of the clinic will gradually be organized, and that, eventually, the clinic organization will include a bureau of vocational guidance. The clinic aims to serve as an educational, social and vocational clearing house for the community. The St. Louis authorities have carefully studied the situation and believe they have effected the best form of organization, linking the clinic, on the one hand, with the training school for teachers, and, on the other hand, making it an integral part of the educational division, with supervisory control of the special classes.

ALMOST every conceivable use to which land may be put is represented in the permits reported by the forest service for special projects on the national forests. Some of the uses shown range, alphabetically, from apiary through brickyard, cannery, cemetery, church, cranberry marsh, fox ranch, marine railway, rifle range and turpentine still, to wharf and whaling station. There are 15,000 permits in force for such special uses, which are distributed geographically from Alaska to the Mexican line, and east to Florida. This figure does not include any of the 27,000 permits in force for grazing cattle and sheep on the forests; nor the 6,000 transactions for the sale of timber, and the more than 38,000 permits issued last year for the free use of timber by settlers, miners and others in developing their homesteads and claims; nor the nearly 300 permits for water power development. California led all the national forest states in the number of these special use permits, followed by Arizona, Colorado, Montana and New Mexico in the order named. The largest single class of permits was for special pastures or corrals, to be used for lambing grounds, shearing pens, and the like. Next came rights of way for conduits, ditches and flumes, practically all of these being free. Various agricultural permits come third, telephone lines fourth with more than a thousand permits for 6,500 miles of line, and drift fences for the control of grazing animals, fifth. In both of these latter classes, too, practically all of the permits are free. Reservoirs for which more than 600 free permits were issued for the occupation of more than 100,000 acres come sixth. The rest of the uses are not classified though there are a large number of apiaries, camps, summer hotels and schools. The use of the government's lands for schools is given free; for hotels a charge is made. The principle which governs the charge is based, according to the forest service, on whether or not the use of the land is sought by the permittee for a commercial purpose. If it is the intent of the user to make money from a resource which belongs to the whole people, the service holds that he should give a reasonable return for that use. If, on the other hand, farmers want to use government land for their own telephone lines, irrigation works and schools, the government gives them that use without cost.

INTEREST attaches to the study of the fossil floras of the Arctic regions, for they indicate climatic conditions very unlike those now existing there. In place of the present almost perpetually frozen soil which supports but a handful of depauperate plants, the conditions from at least late Paleozoic to middle Cenozoic geologic time made possible at least during certain periods, an abundant and luxuriant vegetation, consisting of ferns and palm-like plants that could grow only in a mild and probably frostless climate. Although these lands are now so inhospitable, and hence but rarely visited, an astonishing amount of information concerning their fossil floras has been accumulated, and to this knowledge Alaska has contributed its full quota, says F. H. Knowlton, a paleontologist of the United States Geological Survey, in a short paper on the "Jurassic Flora of Cape Lisburne," just published as Part D of Professional Paper 85.

The fossil plants described by Mr. Knowlton were collected by A. J. Collier, a geologist of the Survey, while engaged in the study of the coal resources of the Cape Lisburne region. The coal deposits are extensive and are the only mineral resources of the region known to be of commercial importance. A little mining has been done by vessels short of fuel, which occasionally lie off shore and load on a few sacks of coal. This, however, is a rather dangerous practise, as there is no harbor. Cape Lisburne is the bold headland which marks the northwestern extremity of a land mass projecting into the Arctic Ocean from the western coast of Alaska between latitudes 68° and 69°. It lies 160 miles north of the Arctic Circle, about 300 miles directly north of Nome, and is the only point in Alaska north of Bering Strait where hills above 1,000 feet in height approach the sea. The Jurassic section to which the name Corwin formation has been given is said by Collier to consist of shales, sandstones, conglomerates and coal beds. Fossil plants occur in the shale beds wherever they have been examined. This formation reaches the enormous thickness of over 15,000 feet and contains 40 to 50 coal beds which range in thickness from 1 or 2 to over 30 feet, ten of them being 4 feet thick and suitable for mining. The various beds aggregate at least 150 feet of coal. Mr. Knowlton correlates the Jurassic flora of Alaska with that of eastern Siberia and concludes that the land connection between North America and Asia at this early period of the world must have been practically continuous. In reviewing the character and geographic range of Jurassic floras, especially as developed in Arctic and Antarctic regions, he states that the wide areal distribution of Middle and Upper Jurassic floras has long been one of the marvels of plant distribution. The living flora of to-day, of course, affords many individual examples of wide distribution, such as those found throughout the tropics of both hemispheres, and others, chiefly weeds, that have, largely through human agencies, spread widely over temperate lands, but altogether these plants form but an insignificant part of the whole flora, whereas in Jurassic time a large percentage of the whole flora was practically world-wide in its range. Even Cape Lisburne is by no means the northern limit of this nearly tropical vegetation; it has been found, preserved in the rocks, 180 miles northeast of Cape Lisburne.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. Helen H. Le Fevre has made to New York University a gift of $10,000 in memory of her husband, the late Dean Egbert Le Fevre. The gift is in the form of a trust to be known as the Dr. Egbert Le Fevre Deanship Fund.

The trustees of the University of Chicago have announced the appointment of a committee to decide on the date and character of the celebration of the twenty-fifth anniversary of the founding of the University. The University of Chicago was incorporated on September 10, 1890.

The New York State College of Forestry has announced plans for the establishment of a course in paper and pulp making.

It is stated in *Nature* that the British chancellor of the exchequer in explaining his budget proposals said that the education grant is to be reconstituted on the principle of making a distinction between the richer and the poorer areas, and between the areas that spend much and those that spend little on education. The increased cost of the exchequer of the education grant will be £2,750,000, but this year the grant will be confined to the necessitous school areas. The government is to contribute one half of the cost of the feeding of hungry school children, and also to make grants for physical training, open-air schools, maternity centers and technical, secondary and higher education. Referring to these grants, Mr. Lloyd George said: "The grants for technical, secondary and higher education are to make it more accessible to the masses of the children, and to extend its sphere of influence where children show any aptitude to take advantage of it. We compare very unfavorably with Germany and the United States of America in this respect.

There there is adequate provision for technical training, secondary and higher training for every child who shows any special gift for taking advantage of it, and I consider that this fact is a greater menace to our trade than any arrangements of tariffs."

AT Cornell University Assistant Professors O. A. Johnson and M. F. Barrus have been promoted to full professorships in the department of entomology and the extension department of plant pathology, respectively.

AT Hamilton College Professor Nelson Clark Dale, assistant professor of geology at Princeton University, will succeed Professor W. J. Miller, who goes to Smith College.

MR. C. G. DARWIN, eldest son of the late Sir George Darwin, has been appointed mathematical lecturer at Christ's College, Cambridge.

DISCUSSION AND CORRESPONDENCE

TWO UNDESCRIBED SPECIMENS OF CASTOROIDES OHIOENSIS FOSTER FROM MICHIGAN

THERE are two specimens of *Castoroides ohioensis* in the collection of the museum of geology, University of Michigan, that were found in the state and have not been recorded. One of these was discovered near Owosso, Shiawassee County, in December, 1892, by A. G. Williams. It is represented by the base and upper part of the right mandible with the incisor and all of the molar teeth in position, the base of the left mandible, and the left incisor tooth. The incisors are well preserved and show the longitudinal striæ and cutting edge, but the tip and base of each are broken. The row of molar teeth is 75 mm. long.

The second specimen, a skull without the mandibular bones, was exhumed in a tamarack swamp in Pittsfield township, Washtenaw county, by J. B. Steere, in 1902. It was lying on a bed of gravelly marl and beneath three feet of peaty soil. The skull is hard, of a rich dark brown color, and is little damaged. The left zygomatic arch is broken, and the teeth, with the exception of the last molar on the left side and the right incisor tooth, are missing. Nearly the full length of the right incisor is represented, the only damage to the tooth being an injury to the outer surface and the loss of a few millimeters from the base. The double nature of the internal nasal orifices is well shown. The measurements are as follows:

	Mm.
Length of skull from occipital angle to forward end of nasals	280
Length of skull from occipital angle to forward end of maxillaries	293
Width of skull across occiput	168
Width of skull across zygomatic arches.	230
Height of skull at occiput	68
Height of skull at last molars	98
Length of nasals	116
Greatest dimensions of zygomatic arch..	67 × 115
Width of occipital foramen	36
Length of molar tooth row	73

The writer is indebted to Professor E. C. Case, of the department of geology, University of Michigan, for permission to publish these records.

NORMAN A. WOOD
MUSEUM OF ZOOLOGY,
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SCIENTIFIC BOOKS

Outlines of Chordate Development. By WM. E. KELLICOTT. New York: Henry Holt & Co. 1913.

In this volume Professor Kellicott endeavors to give a compact though comprehensive account of the development of the Chordates, such as will be suitable for the student of general embryology. For this purpose the frog is taken as representing the type, or rather, one should say, the mean, of chordate development, and a full and connected account is given of its early development and organogeny. This account is, however, preceded by an excellent statement of the embryology of *Amphioxus,* the author believing that whether or not this represents a truly primitive type of development, "it affords, in simple diagrammatic style, the essentials of early Chordate development," while its specialized later stages "may serve to put the student upon his guard

against a too exact phylogenetic interpretation of embryological facts." While admitting the correctness of the first of these statements, from the point of view of the student seeking an outline of the principles of Chordate development one may question the pedagogical propriety of adding a number of more or less irrelevant facts for the purpose of enforcing a conclusion which may be deduced with even greater clearness from the more pertinent embryological phenomena of the higher chordates.

Following the account of the frog, the early development and organogeny of the chick is considered, and the book ends with a chapter on the early development of the mammalia, special attention being devoted to the development of their embryonic membranes and to that of the external form of the human fetus. It is unfortunate for the continuity of the descriptions that no mention is made of the early processes of development of the Reptilia, since these in several particulars afford a much clearer transition to the specialized mammalian conditions than do the similar stages of the chick. The account of the later stages of *Amphioxus* might well have been replaced by a description of the early stages of reptilian development.

But, on the whole, Professor Kellicott's book is an excellent one, both in its conception and execution. The descriptions are clear and without redundancy and are illustrated by numerous well chosen illustrations. Extensive bibliographic lists are appended to the various sections and there is an excellent index.

J. P. McM.

Chemical Technology and Analysis of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. In three volumes. 5th edition. Volume I. Macmillan Company. 1913. $6.50.

This volume has increased from 542 to 668 pages: the chapters on the Constituents and on the Examination of the Mixed Fatty Acids being increased by nearly one third. In view of the encyclopedic character of the book, one is surprised to find no mention of the absolute viscosimeter; of Dunlap's excellent method of purifying alcohol for alcoholic potash; of T. W. Richards' apparatus for distilling in vacuo by electricity, all of which are admirably adapted for work with fats and oils. The information regarding the Saybolt viscosimeter, too, is not the latest, although perhaps the latest published.

The reviewer regards the treatment of the subjects as most thorough and eminently satisfactory. It is wisely critical, showing evidence of investigation done under the doctor's own eyes. It is approached by nothing in any language, as is attested by the fact of its translation into French and rewriting in German. It is invaluable to every one having to do with fats, oils and waxes.

It will be noted with deep regret by all in this branch that the appearance of the book in this country closely coincided with the death of its author.

A. H. Gill

SCIENTIFIC JOURNALS AND ARTICLES

The April number (Vol. 15, No. 2) of the *Transactions of the American Mathematical Society* contains the following papers:

Maurice Fréchet: "Sur la notion de différentielle d'une fonction de ligne."

J. H. M. Wedderburn: "A type of primitive algebra."

C. T. Sullivan: "Properties of surfaces whose asymptotic curves belong to linear complexes."

E. W. Chittenden: "Relatively uniform convergence of sequences of functions."

H. S. Vandiver: "Note on Fermat's last theorem."

E. R. Hedrick and Louis Ingold: "A set of axioms for line geometry."

G. C. Evans: "The Cauchy problem for integro-differential equations."

The March number (Vol. 20, No. 6) of the *Bulletin of the American Mathematical Society* contains: Report of the twentieth annual meeting of the society, by F. N. Cole; Report of the winter meeting of the society at Chicago, by H. E. Slaught; "Shorter Notices"; Zoretti's Leçons sur le Prolongement analytique and Scheffers's Serret's Lehrbuch der Differential- und Integralrechnung, by Frank

Irwin; Meyer's Theorie benachbarter Geraden und ein verallgemeinerter Krümmungsbegriff, by E. B. Cowley; Hilbert's Grundlagen der Geometrie and Grundzüge einer allgemeinen Theorie der linearen Integralgleichungen, by T. H. Gronwall; Lebon's Gabriel Lippmann, Moritz's College Mathematics Notebook and College Engineering Notebook, and Harris's Gravitation, by E. B. Wilson; "Notes"; and "New Publications."

THE April number of the *Bulletin* contains: "An unpublished theorem of Kronecker respecting numerical equations," presidential address, by H. B. Fine; "Two convergency proofs," by Arnold Emch; "Some properties of the group of isomorphisms of an abelian group," by G. A. Miller; Review of Landau's Handbuch der Lehre von der Verteilung der Primzahlen, by T. H. Gronwall; Review of Fisher's Purchasing Power of Money, by E. B. Wilson; "Shorter Notices"; Clebsch-Lindemann's Geometrie, by Joseph Lipka; Weyl's Die Idee der Riemannschen Fläche, by F. R. Moulton; "Notes"; and "New Publications."

THE May number of the *Bulletin* contains: Report of the February meeting of the society, by F. N. Cole; "A non-enumerable well-ordered set," by A. B. Frizell; "Note on the Fredholm determinant," by W. A. Hurwitz; "Time as a fourth dimension," by R. C. Archibald; Review of Bützberger's Bizentrische Polygone, Steinersche Kreis- und Kugelreihen und die Erfindung der Inversion, by Arnold Emch; "Shorter Notices"; Loria's Poliedri, Curve e Superficie secondo i Metodi della Geometria descrittiva and Darstellende Geometrie, zweiter Teil, by Virgil Snyder; Czuber's Differential- und Integralrechnung, by L. W. Dowling; Ciani's Lezioni di Geometria proiettiva ed analitica, by E. B. Cowley; Hessenberg's Transcendenz von e und π and Bolza's Variationsrechnung, by T. H. Gronwall; Picard's Das Wissen der Gegenwart in Mathematik und Naturwissenschaft, by J. B. Shaw; Sturm's Maxima und Minima in der elementaren Geometrie, by J. V. McKelvey; Norris and Craigo's Advanced Shop Mathematics, by P. F. Smith; Czuber's Wahrscheinlichkeitsrechnung, by H. B. Phillips; Lord Kelvin's Mathematical and Physical Papers, volumes IV., V. and VI., and Love's Problems of Geodynamics, by E. B. Wilson; Annuaire pour l'An 1914 publié par le Bureau des Longitudes, Combebiac's Les Actions à Distance and Abbe's Mechanics of the Earth's Atmosphere, by E. W. Brown; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE SYSTEMATIC POSITION OF THE MYLODONT SLOTHS FROM RANCHO LA BREA[1]

IN the excavation work carried on by the University of California in the Pleistocene of Rancho La Brea, a considerable percentage of the material obtained represents ground-sloths of the mylodont group. Twenty-seven skulls, representing the family Mylodontidæ, are now in the collection of the department of paleontology. Of these, nineteen are well preserved and show the dental series on both sides. Many lower jaws are also available, several of which are associated with the skulls. In a preliminary consideration of this extensive series of specimens, certain suggestions as to the relationship of some of the mylodont genera have presented themselves. It seems desirable, therefore, to make this information available for other students of the group.

The writer is indebted to Professor John C. Merriam for kind assistance during this study.

The genera *Mylodon* and *Paramylodon*, to which the Rancho La Brea material has previously been referred, are the members of the family Mylodontidæ definitely recognized in the North American Pleistocene. A fragmentary lower jaw, originally described by Harlan from Big Bone Lick, Kentucky, was referred to *Mylodon* by Owen in 1840. In 1903 Brown[2] established the genus *Paramylodon* on a skull and lower jaw with associated skeletal material obtained from Pleistocene deposits near Hay Springs, Nebraska.

[1] Read at the fifth annual meeting of the Paleontological Society, Princeton, N. J., January 1, 1914.

[2] Brown, B., *Bull. Amer. Mus. Nat. Hist.*, Vol. XIX., Art. XXII., pp. 569–583, 1903.

In 1909 Cockerell[3] briefly described a skull from Walsenburg, Colorado. Brown believed it to be distinct from *Paramylodon* and assigned it to the genus *Mylodon*. Some doubt as to the validity of the genus *Paramylodon* was subsequently expressed by Osborn,[4] though Allen,[5] in a recent paper, accepts the determination of Brown.

The diagnostic characters of the genus *Paramylodon* were stated by Brown as follows:

> Skull elongate; muzzle inflated; dentition $\frac{4}{4}$; first upper molar the largest of the series; last lower molar trilobate; first lower molar without opposing tooth.

The nineteen skulls from Rancho La Brea are similar to the Nebraska and Colorado specimens in the elongation of the head and the inflation of the muzzle. In several of the California specimens the teeth have fallen from the sockets, the study in such cases being restricted to the alveolar outlines. The series arranges itself as follows:

1. Four skulls with four teeth on both sides.
2. Six skulls with four teeth on one side and five teeth on the opposite side.
3. Nine skulls with five teeth on both sides.

The superior dentition varies, therefore, from four to five teeth on each side; and this variation appears to be independent of the age of the individual. It follows from the variable presence of the first tooth, that it is the second superior tooth which is the largest of the series. Upon the presence of the first superior tooth depends, also, the nature of occlusion with the first inferior tooth.

The fourth inferior tooth, in a series of five lower jaws, is most distinctly trilobed in an individual of the first group. The tooth appears slightly less trilobed in individuals of the second and third groups, and may be two-lobed in the last group.

Judging from the variation in the large series from Rancho La Brea, the form described by Brown, as well as the remains from the asphalt deposits, should apparently be placed in the genus *Mylodon*. The earlier authors would probably have arrived at a similar conclusion, had this extensive collection been available. Allen considers the Colorado skull as belonging to *Mylodon harlani* Owen. Possibly the specimens from Nebraska and Colorado are closely related specifically to the Rancho La Brea remains. At present the writer will only state that the inferior dental series of several mandibles from Rancho La Brea bear a close resemblance to the type specimen of *M. harlani*.

A third type of ground-sloth from North America, which has been considered with the Mylodontidæ, is the genus *Morotherium* described by Marsh[6] in 1874 from remains found in Alameda county, California. Marsh considered *Morotherium* closely related to *Mylodon* and *Megalonyx*. It was distinguished from *Mylodon* by the absence of the depression in the head of the femur for the ligamentum teres. The humerus of *Morotherium* differed from *Megalonyx* in the absence of the supracondylar foramen. In 1899 Merriam[7] described a humerus from Pleistocene strata near Tomales Bay, California. It resembled closely the known portion of Marsh's specimen and was referred to *Morotherium*, although the validity of the genus was questioned by the writer.

A comparison of the Tomales Bay humerus with several specimens from Rancho La Brea indicates that the former specimen undoubtedly belongs to *Mylodon*. The writer has not seen the type (femur) of *Morotherium*. As stated by Marsh, it resembles *Megalonyx* in general shape. The specimen, as figured, appears to be quite different in shape from the *Mylodon* femurs of the asphalt deposits. The absence of the notch for the ligamentum teres can hardly be considered as generically distinctive of *Morotherium*, as it may be absent

[3] Cockerell, T. D. A., Univ. Colo. Studies, Vol. VI., No. 4, pp. 309–312, 1909.

[4] Osborn, H. F., "The Age of Mammals in Europe, Asia and North America," Macmillan Co., p. 457, 1910.

[5] Allen, G. M., *Mem. Mus. Comp. Zool. Harv. Coll.*, Vol. XL., No. 7, pp. 319–346, 1913.

[6] Marsh, O. C., *Amer. Jour. Sci.*, Vol. 7 (3), Art. XLIX., pp. 531–534, 1874.

[7] Merriam, J. C., *Bull. Geol. Soc. Amer.*, Vol. 11, pp. 612–614, 1899.

on *Mylodon* femurs from Rancho La Brea. The femur of *Megalonyx*, as figured by Leidy, appears, also, to be without this notch. Possibly Marsh's type should be referred to *Megalonyx*.

CHESTER STOCK

PALEONTOLOGIC LABORATORY,
UNIVERSITY OF CALIFORNIA,
December 9, 1913

THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

WEDNESDAY, DECEMBER 31, 1913, TEN O'CLOCK

Soil Bacteriology

Bacterial Activities and Crop Production: P. E. BROWN.

The importance of correlating the results of bacteriological tests with known facts regarding soil fertility is emphasized. The improvements in methods for the bacterial examination of soils has made possible the study of the relation between bacterial activities and crops produced. Thus the determination of the ammonifying power, the nitrifying power or the azofying power of soils may be an indication of their fertility or crop-producing power, or at least of the relative fertility of several soils.

Soils under varying rotations and under different treatment have been studied during the past three years, and the results secured show in practically every case a similar, definite relation between the crops produced on the various plots and the ammonifying power and the nitrifying power of the soils determined by the fresh soil-casein method for the one and the fresh soil-ammonium sulfate method for the other.

It is evident that the bacterial activities in soils determine very largely the crop-producing power of the soils. If the bacterial mechanism which brings about the solution of insoluble plant food is inadequate, crops will suffer for lack of food. In soils where improper rotations and poor treatment is practised the conditions very quickly become unsatisfactory for optimum bacterial growth and crops immediately feel the effect of this diminished growth in a reduced supply of food. The work, as a whole, therefore, points toward the value of bacterial tests as a measure of the crop-producing power of soils.

The Environment of Soil Organisms: F. H. HESSELINK VAN SUCHTELEN.

Growing out of the importance of the action of media on organisms a study of soil as a cultural medium was undertaken. So far as our present knowledge concerning soils extends, the only means at our disposal for judging the cultural medium of soil organisms is drainage water. It may be expected, however, that the soil solution as it exists in the soil differs quantitatively from the drainage water.

A method was devised for obtaining this soil solution based on its displacement by inactive substances (paraffine oil, vaseline, etc.). Work by means of the determination of osmotic pressure and electrical conductivity was undertaken, which demonstrated the value of such a displacement.

The absolute amount of soil solution obtained by the above-mentioned method varied from 100–435 c.c. solution. As an example of the successful extraction the following data may be quoted. From 7.949 kilograms of sandy loam with a total water capacity of 24.6 per cent. containing 14.3 per cent. water (all figured on the basis of dry soil), there was obtained 330 c.c. of soil solution. The concentration of the soil solution bears a resemblance to the very first portion of drainage water obtained by careful percolation through a large quantity of soil.

Besides an extensive study of the soils employed in our experiments, there were made physico-chemical and chemical examinations of the liquid obtained by the foregoing displacement process, together with a determination of the number of microorganisms found by the plate method. It was ascertained that different soils, soils closely adjacent and the soils of different layers, contained soil solutions of different compositions. Detailed results will appear in a future publication.

A New Medium for the Quantitative Determination of Bacteria in Soil: H. JOEL CONN.

Three special media for soil work have been proposed during the last few years: by Hugo Fischer,[2] by J. G. Lipman[3] and by P. E. Brown.[4] Recently an asparaginate agar containing wholly chemicals of known composition has been prepared at the New York Experiment Station. A fifth medium, a soil-extract gelatin, has been compared with them, because it has been found to give a very high and regular count. The composition of these media are as follows:

[1] Abstract of papers presented.

[2] *Centbl. f. Bakt.*, II., Ab. 25, p. 457.

[3] *Id.*, 25, p. 447.

[4] *Id.*, 38, p. 497.

	Asparag. Agar	Fischer's	Lipman's	Brown's	Soil-Extr. Gelatin
Water	1,000	—	1,000	1,000	900
Soil-extract	—	1,000	—	—	100
Agar	12	12	20	15	—
Gelatin	—	—	—	—	120
Peptone	—	—	.05	—	—
Albumin	—	—	—	.1	
Na. Asparag.	1	—	—	—	—
Dextrose	1	—	10	10	1
$MgSO_4$	.2	—	.2	.2	—
K_2HPO	—	2	.5	.5	—
$NH_4H_2PO_4$	1.5	—	—	—	—
KCl	.1	—	—	—	—
$CaCl_2$	.1	—	—	—	—
$FeCl_3$	Trace	—	—	—	—
$Fe_2(SO_4)_3$	—	—	—	Trace	—

In the asparaginate agar the reaction should be carefully adjusted to 0.8 per cent. normal acid to phenolphthalein. The dextrose and asparaginate should be added just before tubing.

Some thirty-five comparative tests of the gelatin with one or more of the other media have been made. Various soils have been used for inoculating. Incubation has been at 180° C. for seven days with gelatin and fourteen with agar, which allows a very high count (5–50 million in normal field soil). The following figures (referred to in terms of colonies on asparaginate agar as 100) represent instances that seem to be typical:

	Asparag. Agar.	Fischer's	Lipman's	Brown's	Soil-Extr. Gelatin
Case 1	100	170	68	57	113
Case 2	100	85	75	Irregular	93

About forty other tests have been made to determine the best proportions of the various constituents in the asparaginate agar. None have proved more satisfactory than the above formula.

As a result of this work the asparaginate agar is highly recommended. The only medium which seems better, either in respect to count or to the colony differentiation, is soil-extract gelatin; and because of the addition of soil extract this gelatin is not one that can be readily duplicated. The only one of the media investigated which gives a higher count than either of these is Fischer's soil-extract agar, which does not allow good colony differentiation. The detailed results of this work are to be published as a technical bulletin of the New York Agricultural Experiment Station.

Antagonism Between Salts as Affecting Soil Bacteria: Chas. B. Lipman.

With Loeb's conception of physiologically balanced solutions as a basis, the author has carried on experiments dealing with a phase of the subject hitherto regarded as of little significance, namely, the antagonism between anions. The most striking results have been obtained with such antagonism between anions through the use of the so-called alkali salts which commonly include sodium chloride, sodium carbonate and sodium sulfate.

Results of antagonism between the anions of these salts show that both as regards ammonification and nitrification, it was possible to improve the soil as a medium after it had been made toxic for the bacteria in question, by means of any one of these salts, through the addition of any other of the three salts mentioned. Thus briefly, it was possible at times to triple and quadruple the total salt content of the soil and still make it a better medium for ammonification and nitrification than it was with one third or one fourth of the total salt content consisting, however, of but one salt. The author claims for this great significance in the direction of the management and control of alkali land.

Sulfofication in Soils: P. E. Brown and E. H. Kellogg.

Recent work has shown that considerably larger amounts of the element sulfur are removed from soils by the growth of crops than has been supposed. The inaccuracy of the old method used in the determination of the sulfur in crops explains the discrepancy. Soils have been shown to contain in most cases only a limited supply of sulfur, usually a smaller amount than of phosphorus. The problem of the sulfur feeding of plants is therefore coming to be of considerably more importance than it has been in the past. The natural means of returning sulfur to the soil is by the use of farmyard manure or green manure and in these materials it is added in a complex organic form in the proteins. The sulfur in these must be transformed into sulfates to be of use to plants.

Here is where the sulfofying bacteria appear. They are the agents which bring about the change of organic sulfur into sulfates. Many questions immediately arise in a consideration of this point. Do soils have a sulfofying power? Can this be determined? How? What is the relation of the sulfofying power of soils to the sulfur feeding of plants? etc. This work deals with the first question and shows that soils do have a definite sulfo-

fying power which varies with the type of soil, soil treatment, etc.

The sulfofying power of soils may be determined in the laboratory in the following way:

100 grams of fresh soil obtained with all precautions that it shall be representative and uncontaminated are weighed out in tumblers and thoroughly stirred. Then 0.1 gm. of a sulfide (Na_2S) or sulfur is added. Moisture conditions are brought up to the optimum by additions of sterile water. The soils are incubated for 4–5 days at room temperature. At the end of that time the sulfates are leached out by shaking for six hours with water in a shaking machine. The sulfate content of the soil itself is determined and the purely chemical oxidation of the sulfide occurring upon shaking the sulfide for six hours with the soil is also ascertained.

The sum of these two is subtracted from the total sulfate content of the soil after incubation and the difference gives the sulfofying power of the soil, or the physiological efficiency of the sulfuroxidizing bacteria in the soil. Many difficulties have been met in the work and largely overcome. Details regarding these will appear in a future publication. The point to be emphasized by the results so far is that soils have a definite sulfofying power which is determinable in the laboratory and therefore the efficiency of fertilization of soils with organic sulfur compounds may be ascertained for any soil.

Further Studies with Some Azotobacter: DAN H. JONES.

Viability of Azotobacter in Stock Cultures.—Equal quantities of azotobacter growth were taken from cultures grown on Ashby's agar for varying periods of time and plated out in beef gelatin. The relative colony counts were as follows:

Culture 16 days old	9,000 colonies
Culture 2 months old	8,000 colonies
Culture 5 months old	5,000 colonies
Culture 7 months old	4,500 colonies
Culture 1 year and 4 months old...	2,200 colonies
Culture 2 years and 2 months old ..	60 colonies

This work was duplicated with the four varieties of azotobacter under observation with approximately same results.

Thermal Death Point of Azotobacter in Stock Cultures of Different Ages.—The cultures used for the viability test were tested for their thermal death point, by mixing one loopful of culture in 10 c.c. of Ashby's solution and then held in water bath for 10 minutes at the required temperature.

All cultures heated up to 55° C. gave good growth.

All cultures heated up to 65° C. and over gave no growth.

Involution Forms.—Involution forms of azotobacter varying very much in shape and size may appear in cultures grown in Ashby's solution and Ashby's agar at any temperature within growth limits. This tendency to produce involution forms is comparatively slight at 20°–25° C., but excessive at 37° C. Involution forms taken from an Ashby agar culture 2 months old were tested for their power to reproduce in Ashby's agar in moist chambers. Fifteen were held under observation for four days, but during that time only one reproduced. Normal cells present in the same fields produced colonies which overgrew the involution forms.

Azotobacter and Plant Growth.—It was decided to test the power of azotobacter to fix sufficient atmospheric nitrogen for plant growth. Special vessels were designed for the purpose. These were filled with well-washed quartz sand, sterilized, soaked with Ashby's solution and inoculated with azotobacter, controls being kept. After two weeks, grains of wheat were sown in the pots of sand. These all germinated and gave growth-producing plants 16 inches high in one month, but no difference was observed at this time between the culture plants and the controls.

A Possible Improvement in the Technique of Determination of the Ammonifying Power of Soils: T. D. BECKWITH AND A. F. VASS.

One of the difficulties met with in determining the ammonifying power of soils is that part of the ammonia was lost under the older methods. We have found it possible to determine the total amount of ammonia given off by soils by a very simple method of laboratory technique. The soil, generally 100 or 200 grams in content, is placed in a 1,000 c.c. Erlenmeyer flask. In the top of the flask is inserted a two-hole rubber stopper. The air is allowed to enter the flask through the inverted U-tube. The outer tube is made of a simple elbow placed in the other hole of the stopper. This flask thus prepared is connected with a water pressure filter pump. In the series between the soil flask and the pump is placed a wash bottle containing $N/10$ H_2So_4. For purposes of an indicator this acid solution is colored slightly with cochineal. When soil and the material to be ammonified is placed in the soil flask, air is drawn through the system by the filter pump. The ammonia is intercepted by the acid. The indicator in the wash bottle shows the point of neutralization.

When neutralized another wash bottle with an aliquot portion of acid is substituted. A final determination of the amount of ammonia in the soil flask plus that of the acid in the wash bottle shows the exact amount of ammonia given off. A large series of flasks and wash bottles may be served by the same filter pump, using appropriate connections of Y and T tubes with heavy-walled rubber tubing. It is necessary to use screw pinch cocks throughout the system in order to regulate the flow of air through the wash bottles and to see that none are cut off. Such a system should be used and adjusted for at least twenty-four hours before the soil and material to be ammonified are added in order to make sure that all is in perfect working condition.

A Bacterial Disease of the Larvæ of the June Beetle, Lachnosterna Spp.: Zae Northrup.

During the summer of 1912, the larvæ of the June beetle, *Lachnosterna* spp. committed serious depredations to crops. Specimens sent in to the entomological department by the farmers were found to be diseased and were turned over to the bacteriological laboratory for the determination of the etiology of the infection, and, if practicable, to use the living parasite as a remedial measure.

This disease which is characterized by a blackening of the affected parts, was found to be due to a micrococcus, which was found microscopically in smears and in sections from diseased tissue. This organism was isolated from the affected tissues of a living grub and liquid cultures were used for the inoculation of the soil in which healthy larvæ were then placed. Oftentimes infection occurred within a short time; the most marked infection occurred when an incision was made in the integument, a characteristic lesion developing within twenty-four hours. It was discovered that an excessive amount of water in such inoculated soil favored the rapid progress of the disease. This seems to be one of the most important factors in determining the fatality of the infection. This disease may be transmitted characteristically to larvæ of the southern United States June beetle, *Allorhina nitida* and to the American cockroach, *Periplaneta americana,* but is non-pathogenic to rabbits or guinea-pigs. The black pigment characterizing the disease is probably produced directly or indirectly by the activity of the bacterial cells within the larval tissues; the cocci and the integument cells in which they are imbedded do not take the ordinary or the Gram stain but remain dark brown in color. From the characteristic lesions produced by this organism it has been named "*Micrococcus nigrofaciens.*" No results have as yet been obtained in trying out this organism as a remedial measure for the destruction of the white grub. Cultures of the micrococcus have been sent to Porto Rico for this purpose.

WEDNESDAY, DECEMBER 31, 1913, TWO-THIRTY O'CLOCK

Sanitary Bacteriology

A Numerical Comparison of the Organisms Producing Gas in Lactose Bile Isolated from the Baltimore City Water Supplies: J. Bosley Thomas and Edgar A. Sandman.

The water supply of Baltimore city is derived from two streams which flow through a rather populous rural district. The larger stream, which has an average daily flow of about one hundred million gallons, drains a watershed supporting many large dairy farms, while the other, with a flow of twenty million gallons per day, is derived from a watershed supporting fewer dairy farms in proportion to its area, but known to be subject to a greater extent to possible sewage pollution. It, therefore, occurred to us that there might be shown in one of these supplies the presence of a different relative proportion of certain types of organisms than in the other supply; and a pollution derived largely from dairy-farms and creameries is obviously of a less serious character than a pollution caused principally by the introduction of sewage. For the classification of these organisms four sugars, in addition to the customary use of gelatin, were used, viz.: lactose, dulcite, saccharose and dextrose. Endo's agar was used for isolating the organisms in pure culture, and the results of a study of the character of colonies formed on this medium is given in the original paper. The average number per c.c. of the several types of organisms was estimated by considering the number of positive and negative tests in each dilution and following the method described by Phelps before the American Public Health Association in 1907. The results of this work, embracing 383 isolations from untreated water, show an average number of 2.79 organisms per c.c. giving cultural characteristics of *B. coli communis* and *B. coli communoir,* and 9.31 organisms per c.c. giving cultural characteristics of *B. (lactis) aerogenes* and *B. acidi lactici,* in the Gunpowder River, which is exposed to pollution from dairy-farms, in comparison with 5.12 organisms of the former types and 4.98 of the latter types in the Jones Fall supply, which is more exposed to sew-

age pollution. It is, therefore, seen that although the total number of these organisms is about the same in either supply, there are nearly twice as many *B. coli*-like organisms in the supply subject to greater sewage pollution than in the Gunpowder River.

Notes on the Bacteriology of Air and Its Sanitary Significance: C.-E. A. WINSLOW.

Both mouth spray and dust contain buccal bacteria and at times pathogenic forms, and might theoretically constitute sources of appreciable atmospheric pollution. Whether they actually do so or not can only be determined by quantitative studies of the bacteria actually present in air and particularly of the characteristic organisms of the mouth. Two sets of results bearing upon this point are here reported.

A series of 684 examinations of school room air in New York City made by Professor Chas. Baskerville and the writer gave an average of 96 microbes per cubic foot. This includes all organisms developing on litmus lactose agar in five days at room temperature. Two hundred and sixty-eight samples gave counts under 50, 178 between 51 and 100, 112 between 101 and 150, 39 between 151 and 200, 23 between 201 and 250, 12 between 251 and 300, and 17 over 300. Lactose fermenting streptococci (characteristic buccal forms) were found 52 times in 174 cubic feet of air giving an average of 30 per 100 cubic feet of air.

The second series of results includes 64 samples of outdoor air (mainly from New York City streets) examined in the course of a somewhat detailed study of air bacteriology now being carried on by the New York State Commission on Ventilation. The average 20° count of 64 samples was 59 microbes per cubic foot. Twenty-four samples showed less than 25, 18 between 26 and 50, 8 between 51 and 100 and 14 over 100. The maximum count was 395. At 37° in two days the average count was 48 microbes per cubic foot. Thirty-six samples were below 25, 9 between 26 and 50, 9 between 51 and 100 and 7 over 100. Acid forming streptococci were absent from 12 cubic feet of air examined for their presence.

The Usefulness of Dried Stained Smears of Milk as a Means of Determining the Sanitary Quality of Milk: ROBERT S. BREED AND JAMES D. BREW.

A number of tests of the method of making milk smears devised by Prescott and Breed[4] have been made at the Geneva Experiment Station with a view of determining the sanitary quality of milk. It has been found to be a very rapid and efficient method of determining the total germ content where milk contains 100,000 or more bacteria per c.c. The results secured probably represent the real conditions so far as total content is concerned better than those secured on agar or gelatin plates. By means of this test it is possible to separate milk as received at a milk station into two classes by a rapid examination of the prepared smears. The first grade of milk is that in which no bacteria are seen in 5 to 10 or more fields of the microscope. In all but eight of the sixty samples in which no bacteria were found the agar plate count was less than 100,000 per c.c. and seven of the eight which exceeded this figure were less than 200,000 per c.c. Such milk would sell in the New York City market as Grade A, selected pasteurized if properly pasteurized. Inasmuch as a large proportion of the milk received at the particular milk station where the tests were made was of this quality this test would have been used to great advantage because it would have enabled the dealer to raise this part of his milk from Grade B to the Grade A class at no expense to himself or to the farmers supplying the milk except the cost of making the tests, which is fortunately not great enough to be prohibitive.

The second class of milk would be that in which bacteria are readily found with the microscope. Such milk under present regulations would go on the market as Grade B milk if properly pasteurized. The great advantage of this test over plate methods of examinations or other bacterial methods that require an incubation period, is that results can be secured in a very few minutes and a large number of samples can be handled by a single person. Any person sufficiently skilled to handle a microscope can learn the technique and apply the method successfully. The chief weakness of the method at present is that it is so new and has been tried out so little in a practical way that no one knows as yet how the results secured should be interpreted. The bacterial counts obtained are much higher than those obtained from the ordinary plate counts and there is no constant relationship between such counts where single comparisons are made. When a long series of comparisons are made between plate counts and these microscopic counts, it is found that greater discrepancies occur when the total number of bacteria is low than when the total number of bacteria is high. A detailed report on this work will

[4] *Journal of Infectious Diseases*, 7, p. 632, 1910.

be published in a technical bulletin of the New York Experiment Station.

Field Organization and Laboratory Technique, Canadian Section—International Joint Commission Pollution Investigation, 1913: F. A. Dallyn.

Period of investigation—April 10 to October 10, 1913.

Field laboratory located at nine (9) bases, from Fort Frances, Ont., to Kingston, Ont.

Equipment at each base comprised:

2 incubators —18° C., —22° C. and 37° C., designed to hold maximum number of samples.
2 sterilizers, one for glassware and the No. 3 Bramhall Deane Autoclave.
400–500 petri dishes with copper cases, 4 copper 25 c.c. pipette cases containing 30 pipettes each, 3 copper 1 c.c. pipette cases containing 60 pipettes each, 300–400 6-oz. glass stoppered sample collection bottles.
Apparatus for obtaining deep samples.
Several hundred Dumas bulbs, necessary table apparatus and media-making equipment.

Twelve thousand eight hundred (12,800) samples were collected and examined. The determination of the total bacteria count on nutrient agar (+ 10) at 18° -22° C. (48 hours), the count at 37° C. (24 hours), and the quantitative estimation of *B. coli* as indicated by fermentation in lactose bile at 37° C. (48 hours), not less than four (4) dilutions used for the latter—usually 1, 5, 25, 50 c.c. were tubed (1/1000, 1/100, 1/10) only when required. Sample collection points were located on straight lines by a time interval method (checked by different landmarks, buoys and lighthouses). Stoppers and necks of sample bottles protected from contamination by a rubber dam held by a band. The dam was dipped in mercuric chloride solution before being re-used.

Each field laboratory examined on an average of 52 samples per day. *Max. amount* 103 samples per day for 3 days in succession. Ten (10) to twenty (20) daily samples taken at each sample collection point. Special paragraphs on tabulation, accounting system, plating and tubing technique, handling of media, media reaction and washing of glassware.

The Virulence of the Resistant Minority: Frank Schofield.

The work described has been done in an endeavor to obtain facts which would give a satisfactory basis for answering the following questions: Considering bacteria of the same species, have those which exhibit the greatest resistance to germicidal action a corresponding increase of pathogenic power over their fellows which succumb? Or, are the few which survive exposure for long periods to detrimental conditions practically innocuous?

In the experiments done swabs were inoculated from pure culture of *B. Diphtheria* and placed in the sunlight and others in the dark. At the same time definite quantities of special broth were inoculated, incubated for two days and varying amounts injected into guinea-pigs of known weight. Cultures were made from the inoculated swabs at different periods such as 30 days and number of colonies developing noted, for instance 100, then again at 35 days when number of colonies might be 50. By careful manipulation the time when but two or three organisms capable of growing on the culture media were left could be estimated. Such colonies would represent the most resistant of the strain used. From such colonies broth was inoculated and incubated under similar conditions, as at the beginning of experiment. Guinea-pig inoculation was made and results compared with results recorded at commencement of experiment. A series of eleven experiments such as these were undertaken and the results warranted the following conclusion: That cultures made from the most resistant individuals of a strain usually exhibited pathogenic properties similar to the less resistant organisms of same strain, the virulence neither being increased nor decreased materially.

The Influence of the Hypochlorite Treatment of Water upon the Development of Algæ: Carrie M. Derick.

Professor Derick briefly reported some general observations incidentally made by a graduate student, Miss Clare Miller (Mrs. Wasteneys), in the course of a study of the Algal Flora of the Island of Montreal, in 1911 and 1912. Collections of algæ made in October and November, 1911, were maintained in sixty or more aquaria in the botanical laboratories of McGill University. In addition to series in various media, parallel cultures were grown in ordinary tap water. At that time, the city water was being regularly treated with hypochlorite of lime, less than one part to a million parts of water being used. The development of deleterious bacteria being thus prevented, the cultures of algæ in this water, which contained all the necessary mineral nutrients, were unusually vigorous and long-lived. At temperatures about 20° C., blue-green algæ, especially *Oscillatoria tenuis* Ag., *O. splendida* Grev. and *Rivularia hæmatites* Ag., flourished. *Anabæna,* on the contrary, usually died or passed into a resting condi-

tion within a few days. In March, however, it reappeared and grew well. Desmids, such as *Cosmarium*, *Closterium* and *Micrasterias*, as well as *Mougeotia*, *Ulothrix* and *Stigeolonium*, which were collected in the spore stage, germinated and grew readily at a temperature of 20° C. *Spirogyra*, *Vaucheria* and *Cladaphora* were most successfully grown at a temperature of 5° C. or less. The majority of the Chlorophyceæ collected grew vigorously in city water, provided that the temperature was between 5° C. and 20° C. *Vaucheria*, *Scenodesmus* and other Protococcaceæ flourished throughout the year. *Œdogonium* and *Chætophora* developed freely towards spring. Diatoms, such as *Navicula*, were plentiful at low temperatures. By periodically renewing the water to prevent the concentration of the mineral contents and by guarding against excessive exposure to strong light, many aquaria were kept in good condition during the following summer and supplied much material used for class-work throughout the winter of 1912–13. Towards spring, in 1913, *Scenodesmus* and a few other types crowded out less resistive groups, and the cultures were allowed to die during the summer of 1913.

Algæ similarly treated in the autumn of 1913 have not developed well. The summer was unfavorable to the majority and they were not in good condition when collected. *Spirogyra* and other Conjugatæ, several of the Protococcaceæ and *Œdogonium* began to grow after a few weeks. But in December, practically all of the aquaria contained species of *Bacillus*, *Spirillum* and *Vibrio*, as well as one or two water molds. Several factors probably contributed to this result. A less rigorous use of hypochlorite of lime in the treatment of the city water was suggested as a partial explanation by Dr. Adami during the discussion which followed the reading of the paper. It is obvious that when water-supplies are freed from bacteria by means of hypochlorite of lime, such a free development of algæ is permitted as to require treatment by copper sulphate or other measures to prevent pollution.

Toxic Products in Food and Their Detection: CHAS. H. HIGGINS.

Outline of necessity for the formulation of a method which could be used as a standard in routine examinations connected with the administration of the Meat and Canned Foods Act.

Three forms of poisoning in meat food products recorded by Edelmann. These are: (1) poisoning resulting from an infection by the *Bacillus enteritidis* (Gärtner); (2) poisoning resulting from the toxic products of the *Bacterium coli*, *proteus* species, etc., (3) poisoning resulting from the *Bacillus botulinus*. These food poisonings are the result of a direct bacterial infection or the poisoning from toxic products formed during their growth. Methods of detection are bacterial, such as Rosenau's, the *boiling test*, judgment depending upon the odor and the various feeding tests, principally with mice. None of these meet the requirements of routine examinations, as the individual element is an important factor and one that can not be standardized. The method employed is through the preparation of a solution of the material under consideration; in the case of commercial gelatines a ten per cent. solution, and following the method of Rosenau injecting this subcutaneously in amounts of 1 c.c. to 10 c.c., which contain from 0.1 to 1.0 of the original gelatine. For other meat food products the method is similar save that the food is leached with normal saline or distilled water, either proving equally satisfactory. In every case ten guinea-pigs are used, preferably of 250 grams weight, these having been shown to be most suitable for this purpose.

This method was used on upwards of two hundred samples. In one instance untoward effect occuring in sixteen persons, was directly traced to gelatine entering food product. In other cases untoward effect was found to be due to faulty methods of handling.

Proteid products have not interfered with the results and have not led to uncontrollable factors. Judgment depends upon the presence of illness or death among the inoculated animals. Period of observation, five days.

A. PARKER HITCHENS,
Secretary

(To be continued)

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and seventieth regular meeting of the society was held at Columbia University on Saturday, April 25. The attendance at the morning and afternoon sessions included forty-four members. Ex-president Bôcher occupied the chair, being relieved by Vice-president Eisenhart, Ex-president Fiske and Professor Tyler. The council announced the election of the following persons to membership in the society: Dr. T. H. Brown, Yale University; Dr. Josephine E. Burns, University of Illinois; Professor C. F. Gummer, Queen's University, Kingston, Ontario; Mr. G.

M. Hayes, College of the City of New York; Dr. W. L. Miser, University of Minnesota; Professor Maximilian Philip, College of the City of New York; Mr. S. A. Schwarz, College of the City of New York; Professor A. G. Smith, State University of Iowa; Mr. W. A. Wetzel, College of the City of New York. Ten applications for membership in the society were received.

Professor L. E. Dickson was reelected a member of the editorial committee of the *Transactions* for a term of three years. It was decided to hold the annual meeting this year in New York.

The society has recently published the Madison Colloquium Lectures, by Professors L. E. Dickson and W. F. Osgood, being volume 4 in the Colloquium Lecture Series.

The following papers were read at this meeting:

A. R. Schweitzer: "An extension of functional equations."

L. P. Eisenhart: "Transformations of conjugate systems with equal point invariants."

H. H. Mitchell: "The subgroups of the quaternary abelian linear group."

R. D. Beetle: "On the complete independence of Schimmack's postulates for the arithmetic mean."

H. S. Vandiver: "Extension of the criteria of Wieferich and Mirimanoff in connection with Fermat's last theorem."

E. G. Bill: "Note on the curvature of a regular curve in non-euclidean space."

S. A. Joffe: "Triangles whose sides are three consecutive integers and whose area is an integer."

G. D. Birkhoff: "The restricted problem of three bodies. Second paper."

A. B. Coble: "Cremona groups determined by point sets."

Anna J. Pell: "Non-homogeneous linear equations in infinitely many unknowns."

Louise D. Cummings: "On a method of comparison for triple systems."

C. L. E. Moore: "A geometry whose element of arc is a linear differential form."

C. L. E. Moore: "On the centers and radii of curvature of curves traced on a surface in an n-space."

J. E. Rowe: "Invariants of the rational plane quintic and of rational curves of odd order."

J. K. Lamond: "Some applications of a theorem of W. H. Young."

Maxime Bôcher: "On a small variation which renders a linear differential system incompatible."

R. C. Archibald: "Euclid's book on division of figures."

C. E. Wilder: "On the degree of approximation to discontinuous functions by trigonometric sums."

E. J. Miles: "Transversality and orthogonality of space extremals."

P. R. Rider: "Broken extremals in space."

R. L. Moore: "Linear order in terms of point and limit."

T. H. Gronwall: "Triply orthogonal systems containing one family of minimal surfaces."

The summer meeting of the society will be held at Brown University, on September 8–9.

F. N. Cole,
Secretary

The Philosophical Society of the University of Virginia

At the regular monthly meeting of the Scientific Section of the society on February 16 Dr. W. J. Humphreys, Professor of Meterological Physics, U. S. Weather Bureau, delivered an address entitled "Volcanic Dust and other Factors of Climatic Control."

On March 23 Professor Graham Edgar presented a joint paper by himself and Mr. S. H. Diggs entitled "The Influence of the Concentration of Potassium Iodide on the Rate of Diffusion of Iodine in Potassium Iodide Solution."

On April 20, 1914, Professor J. S. Grasty presented a paper on "The Shore Lines of the Ore Beds of the Clinton Formation in Alabama."

L. G. Hoxton,
Secretary

The American Philosophical Society

A paper read before the American Philosophical Society on April 3, by Ambrose E. Lehman, "Explorations in the Hudson Bay Region, with Reference to Unusual Topographic and Hydrographic Features and Mineral Deposits," announces the discovery of rich molybdenite ores, at a point immediately south of the new National Transcontinental Railway, in the northern section of the Province of Quebec, 440 miles northwest of Quebec, Indian Peninsula, Keewagama Lake.

Molybdenite crystals and flakes occur in persistent quartz veins traversing the granite and pegmatite rocks of the Laurentian formation.

Exploration and development of the deposits thus far exposes the ore near the surface, in such quantity as to warrant the belief in the magnitude of the find being greater than any heretofore discovered and developed of this rare metal.